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THE ACCIDENT TO THE STEAMER CITY OF PARIS.

THE accident to the machinery of the great steamer City of Paris, which took place on March 25 last at sea, off the coast of Ireland, on her outward voyage from New York, has occasioned much comment and inquiry in engineering circles. The wreck of the great engine, 10,000 h. p., was complete. Almost in an instant it was transformed from an organized and beautifully working system into a chaotic jumble of bent and distorted fragments.

The first and apparently most correct reason given for the accident was the breaking of the propeller shaft, the sudden fracture of which was supposed to have produced a racing of the engine, by which it was torn to flinders. The cause of the breaking of the shaft was said to be due to the wearing of its outer bearings. *Engineering* gives a detailed explanation, from which we give a few brief extracts, with an engraving:

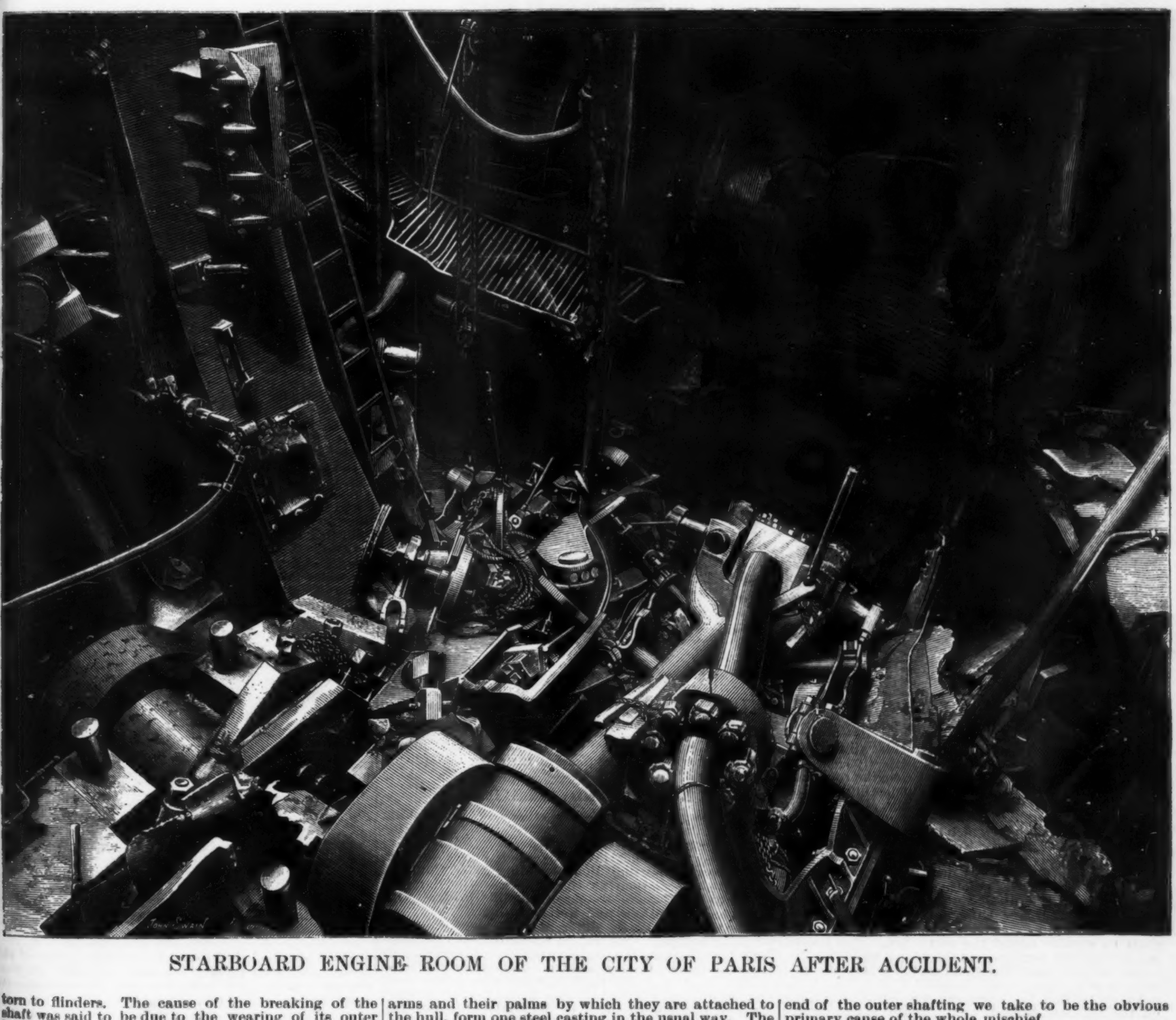
Each of the twin shafts passes through the ship's side through a stern tube in the usual manner. Immediately outside there is a flange coupling of the ordinary description, by which attachment is made to the outboard length of shafting. It was immediately on the forward part of this coupling, and therefore directly outside the stern tube, that the starboard shaft was broken square across. The position of this fracture is not shown in our engraving, it being somewhat forward of the part illustrated. The diameter of this part of the shafting is 20¼ in. The fracture was thick with rust on both faces, but there was every appearance of the metal being sound throughout and of excellent quality. On the whole, we should judge the shaft to be an excellent job, and the fracture to be entirely unconnected with any fault in the material. The outboard portion of the shaft abaft the coupling just referred to consists, we may say, of one length of hollow shafting 42 ft. long, and one length of solid shaft 15 ft. long, this latter length carrying the propeller. The total length of shafting abaft of the point of fracture was thus some 58 ft. or so.

This breakage of the shaft will of course fully account for the racing of the engine, while the subsequent damage done thereby can, we think, also be fully accounted for by causes we shall explain. Proceeding aft in our examination of the vessel, we found the two arms of the stern bracket intact, their attachment to the vessel being undisturbed. At their outer ends they are, or rather were, connected by a cylindrical boss which forms the support in which the propeller shaft revolves as shown. This boss, with the two arms and their palms by which they are attached to the hull, form one steel casting in the usual way. The thickness of metal in the cylindrical part is 3½ in. This boss was fitted with the usual gun metal bush and lignum vitæ bearing strips. The cylindrical part of the casting was split clean across the top in a line with the axis. The reason of this was obvious; when the forward end of the broken shaft had commenced to fall, owing to losing the support of the casing, a twisting moment of considerable force was naturally exerted, and this the casting was unable to sustain. The length of the cylindrical part of the bracket is about 6 ft.

The top part of the bracket was split across when the twisting strain was brought upon it by the release of the forward end of the outside shafting when the casing was cast adrift in the dock. It should be stated that the fracture was quite bright and free from rust, showing that it had recently been made. It will be further evident that the cylindrical part of the casting could not be intact on its bottom side, or the shaft would not be released. There was, however, no occasion for any fracture to occur here throughout, and this brings us to the most interesting part of our report. The bottom part of the casting was worn through for nearly the whole of its length, and much reduced in thickness where not worn through. The metal liner, 1 in. thick, together with its end flanges, was also worn through, and was lying in the bottom of the dock. The brass sleeve of the propeller shaft had entirely disappeared, with the exception of two rings, presumably the collars at the end. The propeller shaft itself was practically undamaged, but the metal studs which attached the sleeve to the shaft were worn down level with the shaft, and the shaft was slightly worn also.

This wearing away and consequent dropping of the end of the outer shafting we take to be the obvious primary cause of the whole mischief.

We will now proceed to give some detailed account of the damage done inside the vessel, as revealed during our examination. Passing through the starboard engine room—not without risk of broken limbs as we scramble over the debris of the low pressure engine—we enter the dynamo room, which is placed immediately abaft the engine rooms, and thence proceed to the starboard tunnel. Here we find the shafting supported by four bearings, and in each case the caps have been broken off; but, so far as we could perceive by aid of a dim light, no damage had been done to the shaft. The brake strap lugs had been broken off, but there was no sign of more than ordinary wear upon the flange on which the strap engages. The journals of the shafting were also in good condition. At the transverse partition forming the forward end of the tunnel, the plating was torn and doubled up to a height of about 6 in. above the shafting. In the dynamo room, through which both port and starboard



STARBOARD ENGINE ROOM OF THE CITY OF PARIS AFTER ACCIDENT.

shafts pass, there are two bearings to each shaft; both of those belonging to the starboard shaft have their caps split. From what has been said it will be gathered that the shafting must have risen bodily when the accident occurred; but, as the stern tube is intact in its position, so far as our observation went, there must have been some bending of the shafting. The couplings of the various lengths have, however, stood the test.

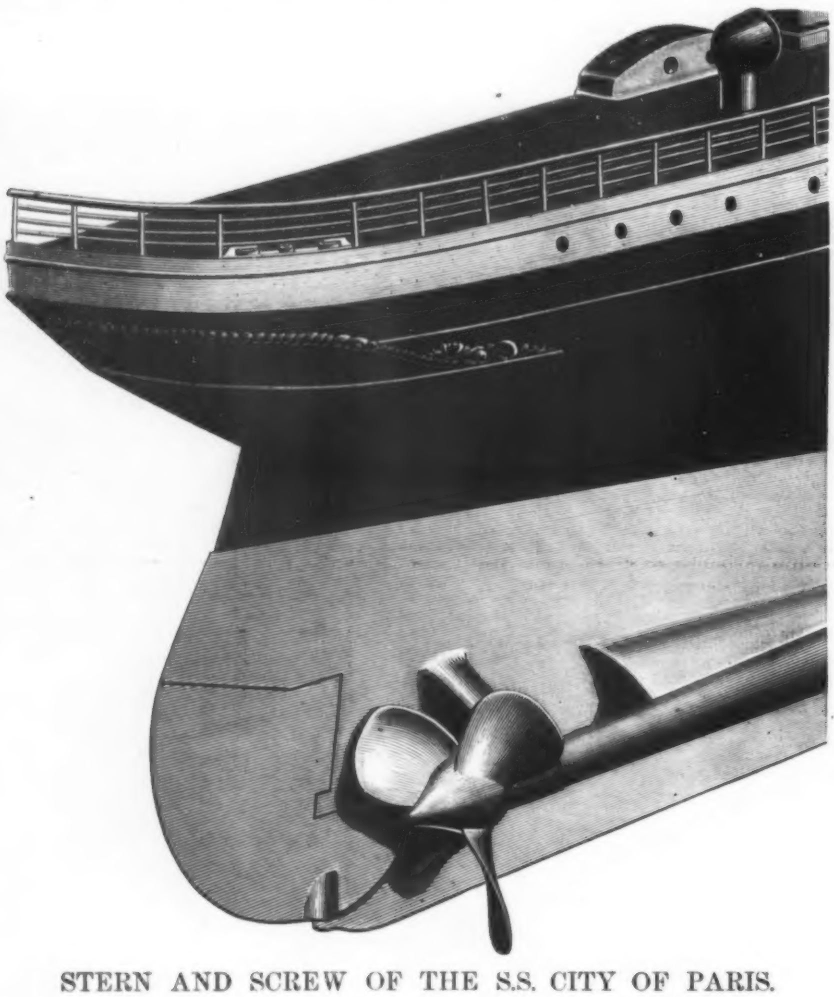
The London *Engineer* gives a view, which we copy, of the engine room as it appears after the accident, and a different theory respecting the cause of the accident, namely, it was due to the lifting of the screw shaft out of its bearings in the engine room; and the breaking of the shaft, which took place afterward, was occasioned by the momentum of the great propeller, on the sudden stoppage of the engine.

"We find," says the *Engineer*, "that the screw shaft was lifted up out of its bearings from end to end, and the lifting up has been of such a character as to prove that the lifting effort occurred in the engine room. The screw shaft is secured to the end of the crank shaft in the usual way by a cheese coupling and bolts. The crank and screw shafts were virtually all one from the forward end of the engine room to the stern tube. The cap bolts of the after bearings on the crank shaft, although 5 in. in diameter, are broken off short, but the cap bolts of the other bearings are intact. Proceeding aft, we find that the cap was torn off the thrust block and the horseshoes scattered about the engine room. From this, back to the stern tube, all the keeps were torn off, save the last. It is perfectly clear that the screw shaft was lifted up in the engine room, and that for the moment it was several inches higher in the engine room than it was at the stern tube. How, it will be asked, was it possible that the shaft could be so lifted, while the crank shaft to which it was secured remained tied down? The answer is curious, and yet simple. The crank shaft is built up. Let us suppose that while the low pressure crank was descending, which would be the case when it was pointing to the ship's side, the screws revolving outboard at the top, some obstruction got under it and stopped it suddenly. The momentum of the heavy screw would tend to cause the shaft to revolve round the crank pin. This it could not do without bursting up the keeps, and even then either the web must slip round on the crank pin or it must twist the pin. Now, in point of fact, the pin has not been twisted, but the crank web has slipped round on the pin, and the screw shaft center is no longer in line with the crank shaft center. It is abundantly clear that something occurred to stop the revolution of the shaft; but further evidence is supplied by a great score in the crank web, due, apparently, to collision with some obstacle.

"But it may be said all this is no doubt true, but the obstacle was something which fell into the crank pit after the engine broke down from racing. A little reflection will show that this proposition is, standing alone, untenable. The screw shaft must have had some powerful twisting force acting on it from the after end, and that could only have been supplied by the momentum of the propeller. Nothing forward of the after crank shaft bearing could have ripped up the screw shaft all along the alley. That resulted from the effort made by the shaft to revolve about a new center when the crank was suddenly stopped; but no rotative effort forward of the after crank shaft bearing could, as we have said, have brought about a lifting effort of the kind wanted. This seems to us to be almost conclusive evidence that the screw shaft did not break until after the engine gave way.

"We are now in a position to advance an explanation which, though not complete, goes some little way toward completeness. The screw shaft was no doubt injured by bending, as we explained last week. The breakdown was brought about by some obstruction which prevented the rotation of the crank shaft. The screw then ripped up the shaft out of its bearings, and the weakened tail end, being unable to bear the strain, broke. The sudden jerk on the guides was, of course, tremendous. The connecting rod was bent, and the steel frames were, by the side effort, snapped off short at the bed plate.

"The question remaining for solution is, What caused the obstruction to the rotation of the crank? This is a point which may or may not be cleared up in the future. We have no certain solution to offer, nothing, in fact, more than a guess, which must be taken for what it is worth. The low pressure piston was a steel casting, with a thin coned body and a heavy rim to take the packing. In such a casting it is almost impossible to eliminate severe initial stresses, set up during cooling. The cracking of large pistons is an exceedingly common occurrence, and we could cite more than one recent case where a thin conical piston has parted from the rod. If the piston broke, and a large portion of it fell to the bottom of the cylinder, the remaining portion coming down on this would cause just such a jar as was needed for the lifting of the screw shaft in the way we have described. The bursting of the cylinder would take place at the same instant.



STERN AND SCREW OF THE S.S. CITY OF PARIS.

POCHET'S MOVABLE DAM.

WE now have practical methods of establishing movable dams in rivers with a relatively invariable bottom, such as the Seine. Experience, in fact, has permitted us to look favorably upon Poiree's system of frames supporting Boule's sliding gates, Camere's jointed shutters, such as they figure at the Suresnes dam, or the Camere system of metallic bridges, with shutters, of the Poses and Mericourt dams.

The case is entirely different with rivers having a shifting bottom. The frames would not operate properly here, because it would be absolutely impracticable to raise them after a freshet, on account of the accumulation of sand that the latter leaves upon the floor. On another hand, the lowering of the Camere shutter frames, and consequently of the shutters themselves, would present just as many difficulties. So, in practice, those various systems have been applied only to watercourses whose bottom is unchangeable.

Mr. Leon Pochet, government engineer, has proposed the construction of a movable dam that offers all the advantages inherent to this kind of work, and capable of operating on watercourses with fixed bottom, but the arrangement of which permits of using it also in rivers with a shifting bottom and of a torrential nature. The system that he has devised presents in addition special features of strength, durability, and simplicity of maneuvering. It may be characterized by the three following features: (1) all the apparatus are of iron or steel; (2) when the dam is open, all the parts are out of water; (3) the opening and closing maneuver is reduced to the setting of a windlass in operation.

As an application, the author has elaborated a dam to be established upon the Seine, according to conditions furnished by the Service of Navigation. This work comprises the following elements: two navigable channels of 50 m. each, and one weir, 97·5 m. in total length, divided into three spans of 32·5 m.

The storage is fixed at 4 m. or even 5 m. above the ground sill of the navigable channel, the ground sill of the weir is established at 2·5 m. beneath the storage; and, finally, the free height between the bottom of the apron and the sill of the channel is 10·8 m. It is supposed that the down-stream water can descend to the level of the sill. In a word, the fall may be 4 or 5 meters, according to the hypothesis.

PRINCIPLE OF THE SYSTEM.

The work consists (1) of a metallic bridge, M (Fig. 1), which we shall call the dam bridge; (2) of a maneuvering bridge, N; and (3) of a system of curved valves, A B, jointed around their center to the down-stream face of the dam bridge, and capable of being raised or lowered through a chain winding around a windlass, T, which moves over the maneuvering bridge. This latter is placed at such a height that the valve raised at A'B, and attached to the apron by two catches, leaves the space between the dam bridge entirely free; that is to say, beneath the line, HH, whose level is determined by the exigences of navigation. Therefore, after the dam is opened, there rests no movable piece under the water, and this prevents chances of damage through alluviums, floating objects, ice, etc. But in such conditions, the dam bridge would alone support all the pressure of the water when the valves were lowered, because, since the sill, A, constitutes but a simple lateral barrier, the resultant of the water pressure upon the valve is annuled only by the resistance of the axis, O, and comes back upon the bridge girders, and this in the case of a large impounding of water, and one of great compass, would lead to the adoption of large dimensions for the girders. In order to bring the whole or a portion of the water pressure upon the masonry sill, Mr. Pochet has adopted the two following arrangements.

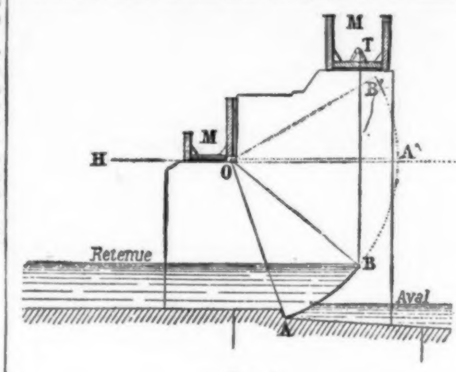


FIG. 1.

VALVE WITH ONE SUPPORT UPON THE SILL.

Instead of attaching the two large girders, OA and OB, to the axis, the upper one, OB, alone remains jointed to it, and the lower one is attached to the end of the small lever, LOK, which is itself jointed to the axis, O. The sill of the dam has a bearing, AC, upon which the valve can rest. Since the lever, LK, is free, the girder, AK, is free likewise, and the pressure of the water will distribute itself approximately in the following manner: ⅔ pressure upon the sill, C, ⅓ pressure upon the upper girder, OB, and consequently upon the dam bridge. In this system the sill supports ⅔ of the water pressure, and this satisfies the condition imposed.

In order to maneuver such a valve, the windlass chain is attached to the end, L, of the long arm of the lever, LOK, after passing it around a pulley, D, upon the valve itself. Let us designate the ratio of the lever arms, OL and OK, by n, and we shall have:

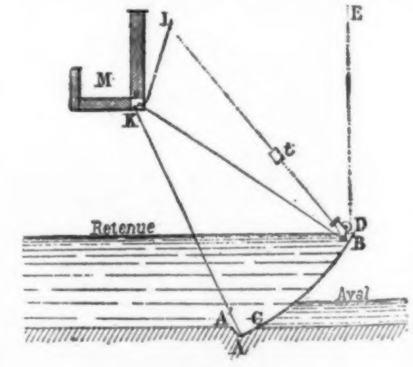


FIG. 2.

$$n = \frac{OL}{OK}$$

Taking no account of friction and the influence of the angles, a tractive stress, F, exerted upon the vertical portion, DE, will be transmitted integrally to the girder, AK, with an intensity equal to nF, which diminishes by so much the pressure of the valve upon the sill. In measure as F increases, this pressure diminishes, and there comes a moment when it is *nil*. Starting from this moment, a slight increase of F puts the valve in motion and makes its lower edge slide along the lateral sill, AA' (Fig. 3). In a word, the valve detaches itself from the sill. This motion continues until a stop, t, on the chain, is applied against the shell of the pulley, D. Consequently the valve can do nothing more than rise to its full extent.

The various operations of the descent of the valve are accomplished in an inverse order. When the valve is out of the water, the stop rests upon the pulley, and

remains there as long as the valve has not touched the side, AA', of the sill. Starting from this moment, the valve no longer descends and the pressure of the water gradually brings its lower edge to the seat in the

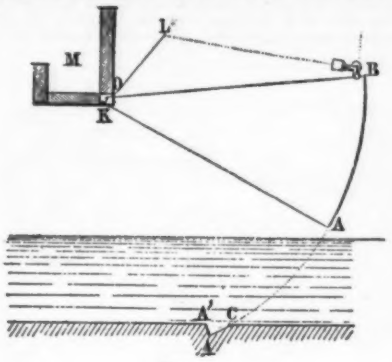


FIG. 3.

sill. This system of valve with single support would be well adapted for medium sized falls.

VALVE WITH TWO SUPPORTS UPON THE SILL.

On fixing at the point, G (Fig. 4), in the center of the arc, AB, of the valve, a support, GE, pointing in the direction of the radius, Mr. Pochet forms a supporting base, AE, upon which the valve will be in equilibrium, since the resultants of the water pressures will neces-

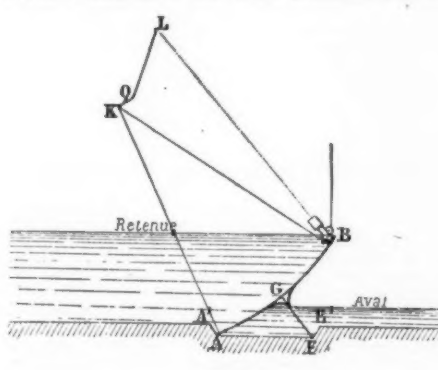


FIG. 4.

sarily pass into the interior of this supporting base. There is no longer a question of anything but combining maneuvers capable of bringing the valve into this position of equilibrium.

To this effect, instead of attaching the lower girder alone to the lower end of the lever, LK, the inventor attaches at this point the two girders, KA, KB. Afterward, the lower girder, KA, presents the peculiarity (Fig. 5) that the eye traversed by the connecting bolt

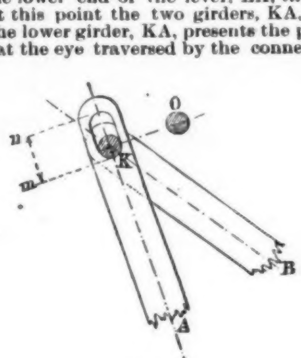


FIG. 5.

upon the lever is elongated by *mn*. The other arrangements are the same as in the valve with one support upon the sill, as already described.

If a stress, F, be exerted upon the windlass chain, this stress will produce a stress, *n*F, upon the joint, K, and this will be transmitted in its entirety to the upper girder, KB, since the lower one, owing to the elongated eye, *mn*, presents no resistance to the connecting bolt. Now, the traction exerted upon the girder, KB, tends to detach the support, GE, from its seat, and to cause the valve to turn around its lower edge, A. When this motion occurs, the bolt, K, follows the lever in its rotary motion around the fixed axis, O, until it touches the extremity of the eye, *mn*. At this instant, a new resistance intervenes—that of the lower girder, which supports two-thirds of the water pressure. The force of traction of the chain will have to increase so as to surmount this new resistance. This condition being fulfilled, the valve will slide along the lateral bearing until the stop of the chain arrests the motion and brings about the lifting of the valve, in its entirety, out of water.

Upon the whole, the lifting of the valve comprises two simple and successive motions: (1) A rotation around its lower edge, A; and (2) a sliding along the lateral bearing, AA'. The descent will consist of inverse motions.

MOVABLE DAM WITH A FALL OF FOUR METERS.

This dam consists of a sluice, of two navigable channels of 50 meters each, and of a lock weir of 97·5 m. in three spans. The height of the storage above the sill in the navigable channels is 4 meters. The weir is at 1·5 m. above the same point. These arrangements correspond, as we have already said, to those that are used on the lower Seine. As the sluice enters into the ordinary system of construction, we shall occupy ourselves only with the navigable channel and the weir.

THE NAVIGABLE CHANNELS.

Each of the two channels is 50 m. in width and contains 20 circular valves 2·5 m. in width. The free height between the bottom of the dam bridge and the sill is 10·8 m. The fixed axis of the bridge is 0·35 m. above. The position of the maneuvering bridge is such that the valves, once raised, may take a position under it, without projecting upon the horizontal traced at 10·8 m. above the sill, and that the pulley of each valve may, in the act of rising, come perpendicular to the windlass. This double condition leads to placing the axis of the maneuvering bridge at a horizontal distance of 9·25 m. from the fixed axis of the dam bridge, and its apron at 18·6 m. above the sill.

The valves have a width of 2·5 m. less a play of 2 or 3 cm. necessary between two consecutive ones, and an extent of 6·8 m. on the edge. Their framework consists (1) of two vertical T-shaped pieces crossbraced by an arcade of boiler plate and angle irons, and resting upon the floor through props. These vertical pieces are spaced 2·04 m. from axis to axis; (2) of two supports having in transverse section the form of a cross with equal branches, formed of 4 plates and 12 angle irons, and set solidly into a forged iron shoe laid down hot and riveted to the angle irons (Fig. 6); (3) of 9 iron crosspieces spaced 0·85 m. from axis to

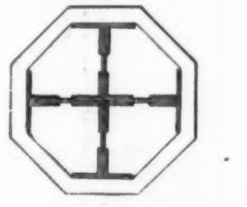


FIG. 6.

axis, in the form of a double T iron, supporting the sheathing; (4) of a steel sheathing formed of 8 plates lapping over each other and riveted to the crosspieces.

Each valve has also four joints for the four girders, one joint for the pulley, two paddle valves, and a service bridge.

The maneuvering bridge is supported by four small vertical girders. The uprights of the parapet are movable around hinges, and are lowered when the valve is raised from the water.

The girders of the valve, which are double T shaped, are jointed to the four angles of the valve, and in pairs at the end of the short arm of the maneuvering lever of the dam bridge. The play of the eye of the lower girders upon the lever is 0·08 m., in order to permit of lifting the supports of 0·05 m. amplitude.

The girders are assembled in pairs by means of a central crosspiece of two round iron St. Andrew's crosses forming stretchers capable of regulation. The pairs of levers are connected above by a crosspiece. A steel cable is attached to each couple, and the two cables of each valve are connected near the stop that forms the end of the chain. The latter begins at the stop, and after running over the pulley, terminates in a hook at the level of the top of the pulley. The windlass carries a pendent chain that is hooked successively to each valve. The windlass is a steam one, with a Field boiler.

The dam bridge consists of a horizontal girder 3 m. in width between the tables, of a vertical girder 4 m. in height on the downstream side, and one 2 m. in height on the upstream side, supporting half of the horizontal girder.

For that part of the bridge that extends over the weir, the calculations suppose that all the valves are lifted at once to a certain height above the sill in order to diminish the storage in case of a great freshet, while the valves of the channels have to be raised one by one only.

The maneuvering bridge consists of two girders spaced 4 m. from axis to axis, and connected by bridge pieces every 2·5 m.; and of string pieces 0·25 m. in height, serving as a support to the sleepers of the windlass track. Besides its own weight, it carries that of all the valves when the dam is raised. As the weight of the valves of the navigable channels is much greater than that of those of the weir, it suffices to give the vertical girders a height of 2·5 m. on the weir, while the height of those of the channels is 4 m.

As there was no occasion for giving the spans of the weir lengths as great as those of the spans of the channels, Mr. Pochet has fixed their dimensions at 32·5 m., and this has permitted him to apply the system of valves with one support, which is more movable than the other, and the simplicity of which is better suited to a mechanism that has to be maneuvered often.

The three spans of the weir are divided into 13 valves 2·5 m. in width.

The dam bridge over the weir is established in the prolongation of that of the navigable channels. As for the maneuvering bridge, that may be lowered by 1·9 m. and is reduced, as to height of girder and weight of metal, by reason of the smaller load, as we have just explained.

The valve consists of two vertical double T frame pieces, six crosspieces and a sheathing which are analogous to those of the large valve, as are also the joints of the girders and valve. As the valves of the weir have to be often raised, each of them is provided with a chain which remains hooked to the maneuvering bridge.

In these movable dams, the floor is submitted to a pulling stress on the part of the upstream pivot, and the downstream pivot supports an almost horizontal pressure. It is possible to overcome these stresses only by providing the masonry of the floor with tie bars connected with longitudinal and transverse girders in order to consolidate the various parts of the construction. The floor thus contains a true metallic framework, whose weight, at the Port Villez dam, reaches 2,000 kilog. per running meter. The floor has to support pressures only that are so oblique that no sliding and no tractive stress results.

In fact, let A B be a valve with prop (Fig. 7), V P be the resultant of the water pressure and the weight

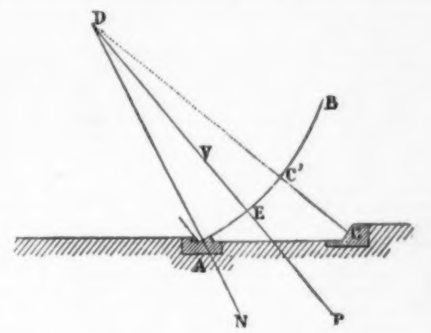


FIG. 7.

of the valve, and C' C be the direction of the prop. If we prolong C' C until the meeting of V P at D, the lines D C and D A will give the directions of the reactions M and N of the sill. The intensity of these is nearly in inverse ratio of the distances C' E, A E. These forces, M and N, are contained all entire in the interior of the cast iron pieces, which carry them back to the masonry, and all entire in the interior of the mass of masonry of the foundation.

On another hand, let A B (Fig. 8) be a valve with one support, let O A and O B be its two girders, and V P be the resultant of the water pressure and the weight. This resultant necessarily intersects the girder, O B, at a point, D, situated to the right of the axis. D A is the direction of the reaction of the sill. This reaction penetrates the interior of the mass of masonry and gives rise to pressures only.

The floor of the dam has therefore no need, theoretically, of any piece of iron bracing. It suffices to establish it in such a way that the pressure of the sill shall be distributed over sufficient surface. Consequently, it is possible to diminish the thickness that is usually given to the floor of movable dams, in the direction of the current, and to almost entirely suppress

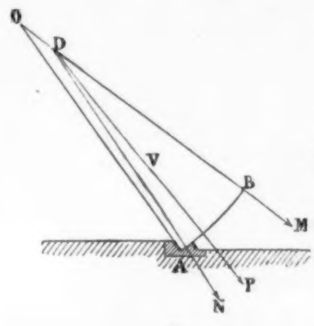


FIG. 8.

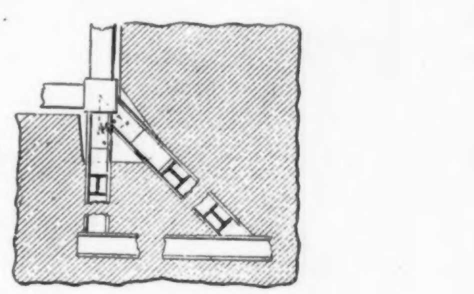


FIG. 9.

the metallic bracing of the foundation. Apart from these economic modifications, the fixed part of these dams does not differ from that of other kinds of dams. The surface view of the floor is constituted of dressed stone and scappled ashlar, as in other dams, and the downstream portion of the floor is protected against undermining by natural or artificial blocks.

The piers are 3·5 m. in width. They are provided with an upstream and downstream breakwater. The height of the pier is 15·85 m., measured inside the breakwaters. The height of the latter is 11·02 m. The crown, which is hollowed by two vaults that support the maneuvering bridge, is 5 4 m. in height. The facing of the piers is of dressed stone and scappled millstone grit.

In order to make the entire mass share in the pressures and to carry them into the interior of the piers, the author admits that the horizontal and vertical girders of the dam bridge must be assembled above the principal coussinet of this work by a rectangular iron plate caisson resting upon such coussinet (Fig. 9). This caisson, which is formed of two cast iron plates at right angles, is assembled with a square of forged iron of the same size carried by an iron plate frame. This latter, which is sunk into the masonry, consists of a triangle of two double T girders 0·6 m. in height and a horizontal girder on a level with the floor.

The axis of each coussinet is placed at 1·05 m. from the facing of the pier, so that the coussinets of two contiguous spans are connected with each other by crosspieces placed here and there, and which carry the pressures back to the whole mass of masonry.

A calculation of the thrusts exerted upon the dam bridge shows that their resultant makes an angle of at least 45° with the vertical. It will, therefore, pass into the interior of the trestle, all the pieces of this will be compressed, and there will be no tractive stress anywhere upon the masonry.

An iron foot bridge over the sluice puts the dam

bridge in communication with the lock keeper's house. A stairway within each pier leads from the dam bridge to the level of the service bridge of the valves.

DAM WITH A FALL OF FIVE METERS.

The mode of constructing the valve and dam bridge is the same as in the 4 m. dam, and the width of the piers is also the same, but their height is increased by 8·45 m., and the width of the flow by 3·55 m. The height of the downstream girder of the dam bridge is increased to 6 m., and an analogous girder is placed upon the downstream head of the piers. These two vertical piers are connected by transverse girders with lattices one meter in height, placed at every 2·5 m. in the intermediate spaces of the valves, and connected by string pieces and a flooring, so as to constitute a true bridge.

Upon each pier two lattices 5 m. in height crossbrace the two vertical girders of the same span. This metallic framework constitutes for each span a sort of rectangular box 6 m. in height, 17 in width, and 50 in length, closed by a metallic crosswork upon all the faces save the lower one, which is left free for the maneuvering of the valves.

The advantage of this system is that it reduces the height of the masonry from 18 to 11·48 m., and that of the structure generally from 22 to 18·48 m.

What characterizes the system is that, as the opening and closing of the dam is reduced to the maneuver of a windlass, it can be hastened or retarded at will.

This kind of a dam is more particularly adapted to rivers with a shifting bottom. When a dam is raised during winter freshets, the water deposits material over the whole extent of the floor. When the level of the water has lowered sufficiently, there comes a moment when the dam must be closed. The obstruction of the sill by sand and gravel renders the closing of the dam impossible, in the dam with trusses as well as in the Camere dam. The putting of the apparatus in place in the two systems supposes the sill free. The same difficulties are not met with in the Pochet system, for it is capable of operating under just such circumstances. In measure as a valve of this system descends, it creates a current beneath it whose power increases in measure as the water in the dam increases, and which completely clears the sill and permits the valve to take its place.—*Le Genie Civil.*

THE STEAM TRICYCLE.

IN our SUPPLEMENT, 746, we gave a brief account of this machine, with a sketch. We now give another engraving of the same. It is the invention of M. Serpollet, who, with a companion, lately made a successful trip with the vehicle from Paris to Lyons. We regret we have not the full details of construction. It is probable petroleum is the fuel used. In our SUPPLEMENT, No. 624, is given another form for a steam tricycle, which is propelled by petroleum.

M. SERPOLLET'S STEAM TRICYCLE.

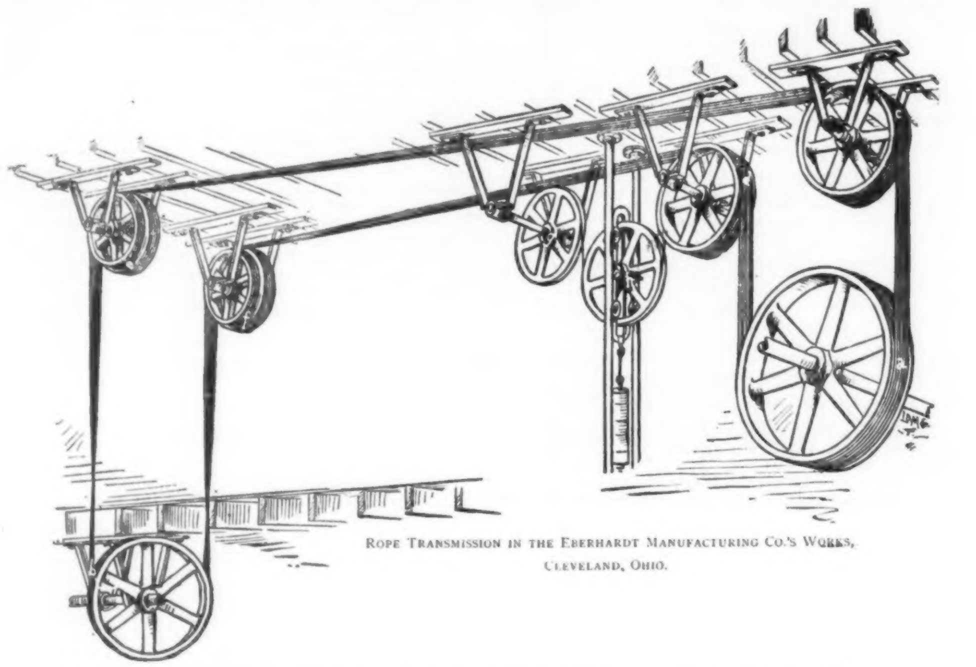
ATTENTION is called to the fact that the combination of sawdust and flour, recommended for covering steam and hot air pipes, is very combustible.

TRANSMISSION OF POWER BY MANILA ROPES.

By JOHN H. GREGG, Member Western Society of Engineers.

A DOZEN years ago, the factories in the United States that were using rope gearing as the method of transmitting power wherever it could be economically employed could be counted on one's finger ends.

There were a few large cotton mills in the New England States that were using the English system of separate ropes to transmit power from the prime mover to their line shafts.



ROPE TRANSMISSION IN THE EBERHARDT MANUFACTURING CO.'S WORKS, CLEVELAND, OHIO.

In the past two or three years, so prominently has the subject of rope gearing been brought before the public, that few large power plants have been erected where the subject of using this method of power transmission, in preference to any other, has not been seriously considered.

The sudden rise into popularity of rope gearing is mainly due to its having been adapted to American ideas, making it possible to use this form of transmission in our present factory buildings; and also to the growing feeling of dissatisfaction with belts. So strong has this feeling become that rope gearing threatens to supplant belt gearing in public favor.

The English system employs independent ropes, so that if there are ten grooves in the sheaves, there are ten ropes, and ten splices to take care of. The driving force depends on the weight of the ropes, and the shafts are spaced not less than 50 feet apart, and slack must be taken out of each rope separately.

The American system employs one continuous rope, independent of the number of grooves in the sheaves,

MANILA ROPE TRANSMISSION IN THE NINE-STORY POWER BUILDING OF THE WESTERN ELECTRIC CO., NEW YORK CITY.

and an automatic tension carriage for taking out the slack and giving the ropes traction—the driving force depending upon the amount of weight put on the pullback.

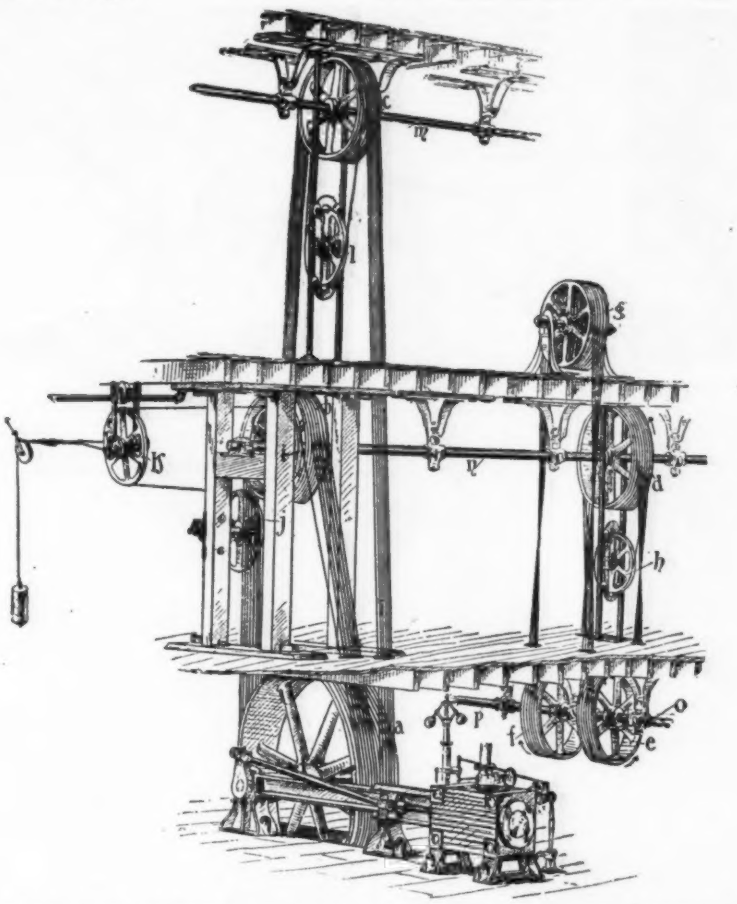
The sheaves for rope gearing are of two kinds, drivers

and idlers, distinguished from each other by the shape of the grooves. The groove for driving sheaves that has been most generally adopted is one in which the included angle is 45°. The ropes are not allowed to bottom, but get a very large traction force from the ropes wedging in the V grooves.

The groove for idlers or carrying sheaves is semicircular, the diameter of the groove being a trifle larger than the diameter of the rope.

per minute has transmitted over 40 H. P. for nearly two years.

The difference between the English system of independent ropes and the American system of a single continuous rope with tension carriage may be readily seen by comparing the plan of the rope gearing as erected for Geo. Knowles & Sons, limited, and the perspective sketch of the rope transmission as designed for the Western Electric Co.'s New York building, for



THREE-ROPE TRANSMISSIONS IN J. K. RUSSELL'S WORKS, CHICAGO. 250 HORSE POWER ENGINE.

Some of the advantages over gearing may be briefly stated as follows:

1. The rope system is almost noiseless.
2. Ropes do not pick up the dust and dirt in the room and deposit it on the ceiling.
3. Ropes can be laid almost anywhere. It is almost impossible to find a place where it is *not possible* to get a rope.
4. For large powers, ropes are much cheaper than belts.
5. The tension on the ropes can be regulated with the utmost nicety, reducing journal friction to a minimum.
6. The driving and driven sheave may almost touch each other and still be successfully driven with ropes.
7. The driving and driven shaft may be out of line—in long distances—to an extent without affecting the durability of the rope.
8. With properly prepared ropes, they can be run as successfully out doors as in.
9. Power can be transmitted to long distances very economically.
10. About one-half the space is required to transmit the same power as compared with belts.

The power which ropes will transmit depends on their size and the velocity with which they are run. In a recent article Louis I. Seymour publishes a table complied by E. D. Leavitt, Jr., who has made a careful investigation of the English and American practice.

The horse power of ropes according to this table is as fcllows:

Feet per minute.	1000	1500	2000	2500	3000	3500	4000	4500	5000
	Horse Power.								
Diameter of rope.									
¾ in.	1¾	2¾	3½	4½	5½	6¼	7	8¾	9
1 in.	3¼	4⅔	6½	8	10	11	13	15	16
1¼ in.	5⅛	7½	10¼	13	15	18	20	23	26
1½ in.	7½	11	15	18	22	26	30	34	37
1¾ in.	10	15	20	25	30	35	40	45	50
2 in.	13	19½	26	33	39	46	52	59	65

He also gives as a safe formula for ordinary practice the following:

$$\frac{G \times D \times R}{200} = \text{H. P.}$$

when

G = circumference of the rope.
D = diameter of the sheave in feet.
R = revolutions per minute.

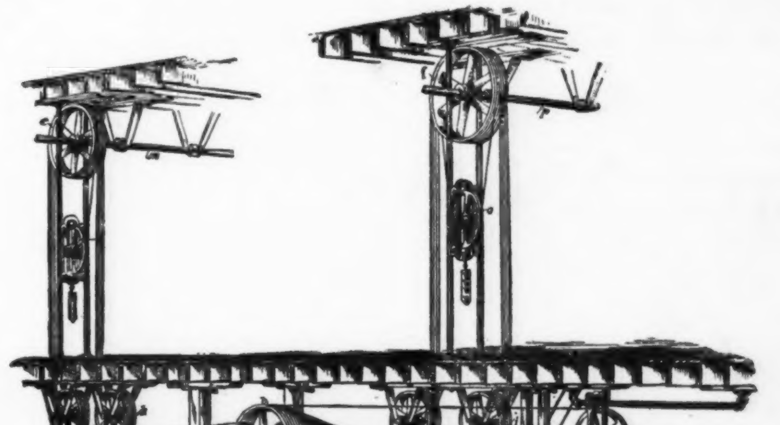
In the above table at 3,500 feet per minute a ¾ inch rope will transmit 6¼ H. P. At the Chicago Arc Light & Power Co.'s plant they are running successfully 50 light dynamos with two ¾ inch ropes. The ropes travel with a velocity of 3,516 ft. per minute and transmit 50 H. P., or nearly four times as much as the power given in the table.

At the Western Electric Co.'s Chicago building, a single ¾ inch rope having a velocity of about 2,000 feet

although the power of the two plants is widely apart, the general arrangement of the two systems is still farther apart, and while in the English system a large independent rope alley is usually required, the American system takes up a comparatively small space.

The Western Electric plant was originally designed to transmit 150 H. P. through the several floors of the building, and was to have two independent continuous ropes with separate tension carriages. Driving to the second floor with six ropes and to the floors above with six ropes, making twelve ropes on the driving sheave. They have been transmitting over 225 H. P. with one of these ropes, driving with three ropes to the second floor, and three ropes to the floors above.

It may be of interest to here note that in the Western



THREE-ROPE TRANSMISSION IN THE LINK BELT ENGINEERING CO.'S WORKS, NICETOWN, PHILADELPHIA, PA.

Electric transmission each floor is provided with a friction clutch cut-off coupling, by means of which, in case of accident, on any floor, the power can be cut off without interfering with any of the other floors.

The other three perspective sketches given are examples of successful rope transmissions, also designed and carried out by the Link Belt Machinery Co., of Chicago. The one designed for the Eberhardt Mfg. Co. shows one of the methods adopted for driving shafts at right angles.

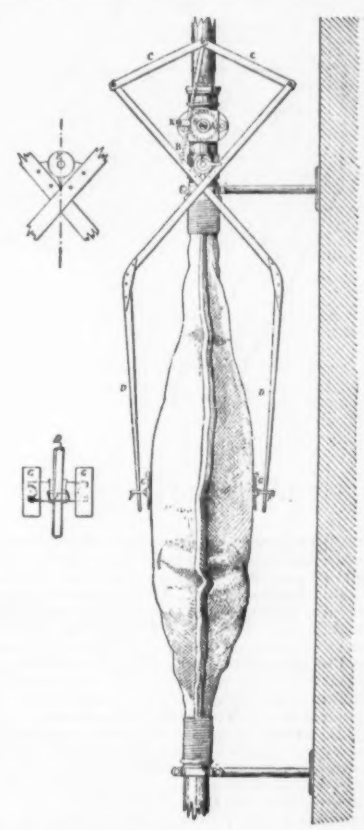
The tracing of the plant furnished to the Southern Pacific R.R. Co. shows one of the peculiar advantages of rope transmission. Here it was required to operate four widely separated barrel elevators, and in no other way could they be driven so cheaply and so well as with rope gearing.

The ropes used for transmission purposes are made from the best quality of Russian hemp laid in tallow. They should be hard but pliable and perfectly smooth to the touch, having no rough or loose ends. The color is yellowish gray—black spots indicating fermentation in the process of curing. It should be laid up in three stands, because three-strand rope is easier to splice and there is less of the rope cut away in forming the splice.

The average breaking strength of the manila rope is about 10,000 lb. per square inch.—*Journal of the Association of Engineering Societies.*

POCKET VALVE FOR GAS MOTORS.

MESSRS. Bizot & Akar are constructing a special cock that prevents the vacillation of the flames of gas burners placed in the vicinity of gas motors.



The apparatus consists of a butterfly valve whose arrangements are shown in the accompanying figure. The valve is controlled by a cogwheel, A, fixed upon its axis and actuated by a rack, B, set in motion through the intermedium of a lever, C, jointed to two branches, D D.' These latter, connected with a pivot, E, engage at their extremities with the rings, F F', of the appendages, G G', at each side of the pocket. They thus follow the motions of inflation and discharge, and cause the valve to act in such a way as to secure an ever sufficient passage, or to close it before the complete inflation of the pocket. In this way, there is obtained

an automatic regulation of the supply of gas necessary to respond to the consumption, while at the same time suppressing the variations of pressure that the abrupt suction of the motor usually produces in the conduit.

The apparatus is simple and strongly constructed. It contains no delicate parts, is visible and accessible at all points, and requires no regulation. It has already been applied to a certain number of motors by the Society of Gas Motors, as well as by the Parisian Company, and its operation has given satisfaction.—*Revue Industrielle.*

IMPROVED SEPARATOR.

WE illustrate herewith Mumford & Moodie's separator for separating hard substances and obtaining a uniform fine product. Briefly described, it is an apparatus wherein a current of air circulating continuously through a descending stream of ground material separates the finer particles from the coarser, the latter being then returned to the pulverizer, millstones, or other grinding machinery, to be further reduced. In Fig. 1 we show a section of the apparatus, which is made of cast iron. The outer casing, A, collects the finer dust, which falls to the spout at the bottom, and is collected in bags or casks, as desired, while the coarse particles fall into the inner casing, B, and are delivered to the right and left through the branch pipes, *a a*, by moving the valve, *c*. The material is thrown against the hood, D, which is made in different sizes and forms, so as to vary the degree of separation and quality of the separated products. The blades of the fan, E, are connected by arms to the disk, E^1, which is rotated by gearing attached to the fan spindle, E_2.

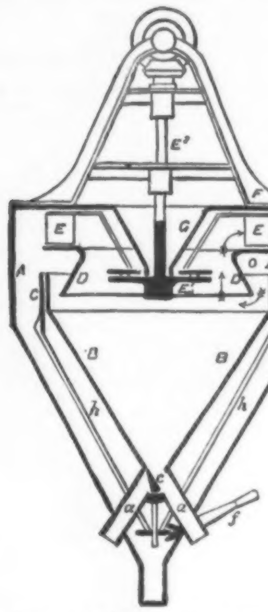


FIG. 1.—VERTICAL SECTION.

The machine will be found useful in many industries, and we understand that it has already been supplied for separating the finer particles from the coarser in ground basic slag, chrome ore, gold quartz, cement, phosphates, limestone, coal, charcoal, coke, animal char, bones, paint, indigo, tanning materials, and for cleaning linseed and other seeds. It can be used in the place of sieving, and will be found to work more economically and with greater efficiency than any hand process. The makers are Messrs. Askham Bros. & Wilson, Limited, of Sheffield, England.—*Industries.*

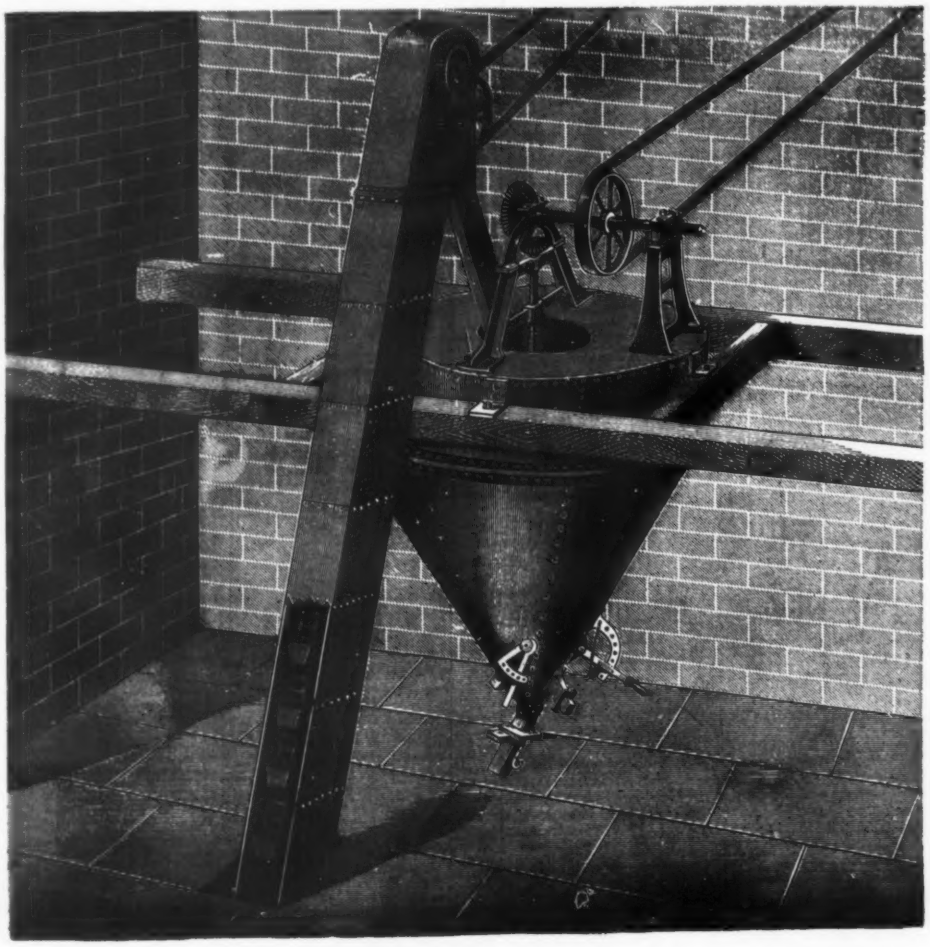


FIG. 2.—IMPROVED SEPARATOR.

A DIVIDING MACHINE FOR AMATEURS.

THIS machine is shown in Figs. 1, 2, and 3, Fig. 1 being the front view, Fig. 2 a side view, and Fig. 3 a central cross section showing construction.

To all who are familiar with fancy chucks provided with dividing plates these machines will be familiar, and need no description. But to many who are not so familiar the machine may be of service and need, and hence the following description is given.

A in each figure is a heavy face plate, preferably of cast iron, gotten out to fit the lathe accurately, particular attention being given to get a perfectly true face. It adds to the looks and also to the accuracy of the plate to turn it up and finish it all over in the well known way, to take out the warp and spring of the iron.

After it is turned up and fitted accurately, a recess is turned out to receive a sound steel plate, Q, in Fig. 3, which is set in it tightly, fastened with screws, as shown, and then accurately turned off flush with the plate, and polished.

A central hole is then drilled through the plate and threaded, and into the hole a plug of steel, O, in Fig. 3, previously got out and threaded at one end, is tightly screwed. It will be noted that the plug has a shoulder that should come up fair and square against the plate, Q.

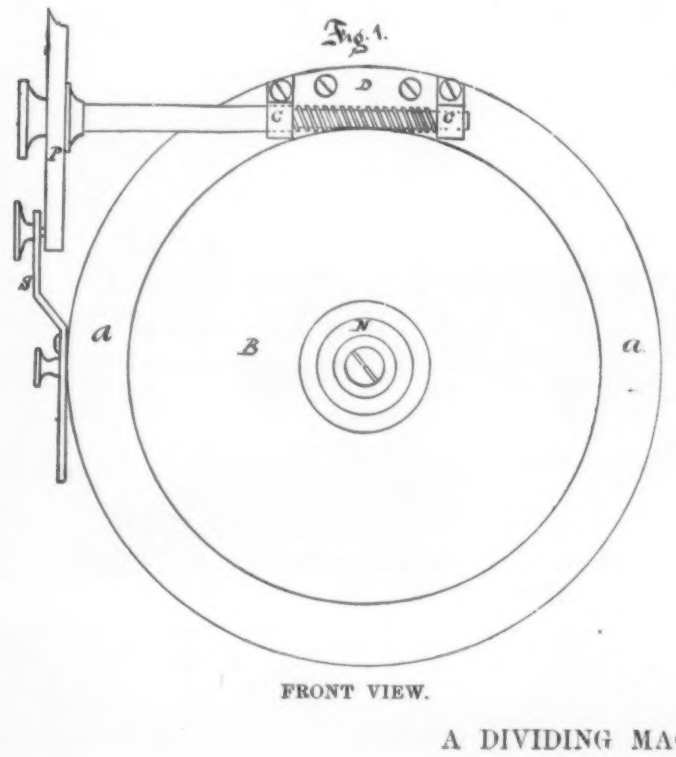
The plug of steel can now be accurately turned down to a conical shape, as shown, this turning being done after the plug is in its proper place, and securely fastened by a big screw, drilled and tapped in the joint if necessary. This plug should, however, screw in so snugly as not to need a key screw to hold it in place. The end of the plug is then to be drilled, tapped, and fitted with a heavy screw for use to be presently described.

The base of the machine is now complete, and the dividing wheel next needs attention.

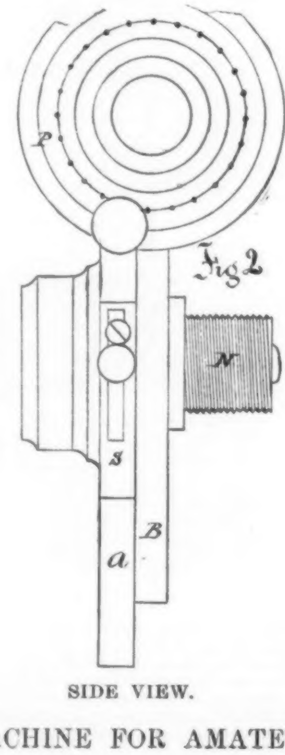
B is the dividing wheel. It can be of brass, cast iron, or of steel. If the amateur has no gear-cutting machine, the wheel will have to be bought to secure an accurate wheel. It is a worm wheel, and preferably with a number of teeth that is an aliquot part of 360. The wheel from which the drawing was made has 180 teeth that fit a worm screw of ten threads to the inch.

Into the center of the worm wheel a steel nose is screwed, as shown in Fig. 3, at N. This nose is bored out with a conical hole to accurately fit the plug, O, and cut with a thread and shoulder at the back end. The front end may be left blank at first. It is screwed in tightly as stated, and the whole may then be slipped upon the plug, E, and secured by the heavy screw and recessed washer, S' and W, Fig. 3 The wheel, B, may now be locked or clamped securely to A, and the nose, N, accurately turned off and threaded. It will then be certain that the nose, N, will run true, and be true in all positions of the dividing wheel, provided plug, O, has been accurately turned off.

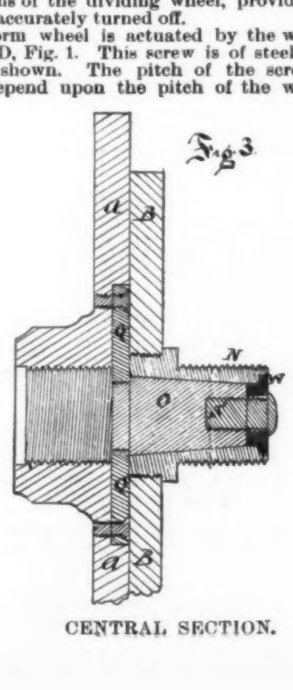
The worm wheel is actuated by the worm screw, shown at D, Fig. 1. This screw is of steel, with long stem, as shown. The pitch of the screw will, of course, depend upon the pitch of the worm wheel.



FRONT VIEW.



SIDE VIEW.



CENTRAL SECTION.

A DIVIDING MACHINE FOR AMATEURS.

They should match accurately and *snugly*, so as to avoid "back lash."

The worm is held upon the plate, A, by the two clips that are drilled to receive the stem and small journal at end of screw, as shown at C, Fig. 1, or a plate of metal with two ears may be got out, as shown at D, Fig. 1.

The stem of the screw is prolonged, as shown, and is provided at its end with an index plate, shown at P, Figs. 1 and 2, which index plate may be drilled with whatever number of holes one may wish. Various division circles are indicated at P, Fig. 2, and one circle is shown with twenty-four divisions.

The index plate is held from turning by the spring stop, S, Figs. 1 and 2, which is fastened to the edge of the plate, A, and is provided with a slot, as shown, so as to enable it to be set to any of the circular divisions.

From the description, as given above, and an examination of Fig. 3, it will be seen that the work to be divided is to be fastened in a chuck, or to a face plate, and then screwed upon the nose, N. This nose and the dividing wheel are practically one, and turn freely upon plug, O, which is accurately centered (by its turning) with the lathe spindle. Any work, therefore, to be divided will be accurately spaced by turning the dividing wheel so as to give the number of divisions or spaces that may be needed.

The machine from which this drawing was taken was made by the writer to graduate circles into degrees in order to make graduations for compasses, galvanometers, etc. The dividing wheel was, therefore, made with 180 teeth, of a circular pitch of 10, so as to fit a worm screw of a pitch of 10 to the inch. This was chosen because the tools at hand made it the easiest to construct. The number of teeth, however, was determined as above stated, so as to be an even part of 360, so as to give degrees or portions of a degree with the greatest facility.

The index wheel or plate, P, has its greatest circular division at 40. This was taken as giving $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ turns to the worm screw. The dividing wheel having 180 teeth, one full turn of the screw would move the work 2 degrees; $\frac{1}{2}$ a turn, 1 degree; $\frac{1}{4}$ turn, $\frac{1}{2}$ degree; $\frac{1}{8}$ turn, $\frac{1}{4}$ degree, and so on, down to $\frac{1}{40}$ of a turn, which would give a division of three minutes.

To use the machine the following method was adopted:

The work to be graduated was accurately turned up and polished in a true running chuck, or soldered to a brass soldering chuck, as the case might be. It was then put upon the nose, N, and run up snug, the dividing machine being in its place on the nose of the lathe spindle.

The lathe head is then locked in position, so as not to move the least particle. A tool with a horizontally placed chisel cutting edge is put in the tool post, accurately adjusted to exactly correspond to the height of the center of the lathe, so as to be sure to mark radii upon the circle to be graduated.

A stop or gauge is then fastened to the lathe bed, so as to regulate the depth of cut as the tool is brought up against the work, a gauge having been constructed that could be used to regulate this depth by the 0·001 of an inch. A stop is also secured to the tool carriage itself to regulate the extent of the cut across the face of the scale.

Preferably the degree marks are made first all around the circle.

The tool is rolled up against the work gently by moving the tool carriage against the stop, and the tool is then drawn across the face of the work by the cross feed screw until the tool block brings up against its stop. The carriage is then rolled back a half turn from the index plate, a second cut made, and so on around the circle. This gives all the marks the same length absolutely, which would not be the case were another method used.

To indicate the division at every ten degrees, as is usually the case on all scales, the index plate is now turned five times around, and the mark it drops into recut to the length desired, the stop on tool carriage having been moved back so as to give that length of movement to the tool. Five turns again, and another ten degree division is made, and so on around the circle.

The five degree marks are similarly made, the stop put to make the right length of cut, two and one-half turns gives the first five degree mark from which we left off, and then five turns again for the next five degree mark, and so on around.

With careful work and a well made machine, the graduation should be accurate. The writer has thus gone around a circle three times, and every cut the second or third time fell exactly upon the mark made the first time around.

To avoid errors from "back lash," if a mistake is made in turning the index plate so as to have gone too far, it is not enough to simply turn back to the hole giving the proper division. The turning back should be away by the hole, and then turn forward again slowly, and then take up all "back lash" before the pin drops into the correct division.

To assist in keeping track of the proper holes in the plate to give the graduation desired, it is well to fill all the holes except those in use for the time being with chalk upon the circle that is being used, but care and attention will prevent mistakes.

The tool will make a slight "burr," no matter how sharp. After the graduation is complete, the work may again be driven by the lathe, the dividing machine having first been removed, and the slight burr removed by a *very light* cut with a sharp tool, or it may be polished down with any of the well known polishing methods.

To give the well known black marks to the graduation, the following method may be used:

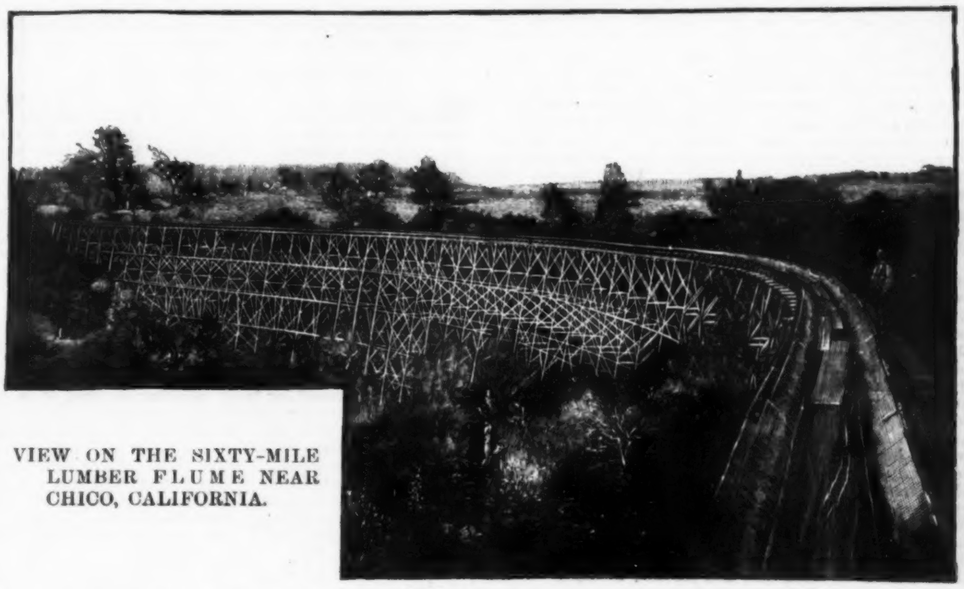
The scale is varnished over with a little thin shellac, so as to sink into all the cuts. When this is dry, a black varnish of lamp black and shellac is spread on, so as to fill all the cuts. This is allowed to *thoroughly* harden. When hard, the work is driven in the lathe, and the superfluous varnish polished off with fine flour emery cloth until only that in the cut is left. This gives a finely finished and distinct marking to the scale.

It is obvious that by the proper use of the principle of this dividing machine, graduations down as fine as one may wish may be made. With teeth enough to the wheel, and fine divisions enough to the index plate, one may go down to so fine a graduation as to be invisible to the unaided eye; or, another way, a compound machine may be made by driving the index plate by a worm screw, and so got down to microscopic work.

The amateur then has a simple means to graduate all his work, and as finely as he may desire. The accuracy will depend upon the truth of the worm wheel and screw, and in the general case any error will be reduced by the proportion of the diameter of the circle to be graduated to that of the dividing wheel. It is well, therefore, to make this latter wheel as large as possible—the bigger the better, so long as the lathe will swing it.

Besides graduating circles into degrees, this machine may be used to lay off and to drill a finely divided index plate, or to space off any work as may be desired. Fastened to the back spindle, with a "set-off" and tools, such as were described in a former article, the index plate may be drilled with any divisions desired, and other work done in a manner sufficiently obvious to need no description.

C. D. PARKHURST,
Lieut. 4th Artillery.



VIEW ON THE SIXTY-MILE LUMBER FLUME NEAR CHICO, CALIFORNIA.

CALIFORNIA REDWOOD LOGGING.

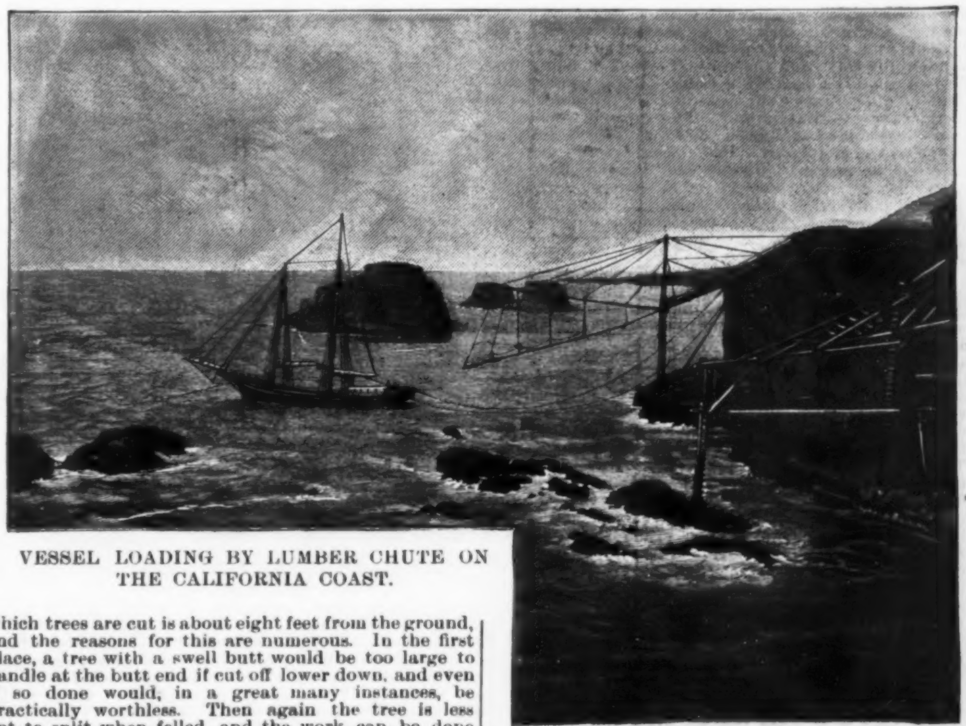
By C. E. POTTER.

A VISIT to the scene of logging operations in the redwood country is usually an eye opener to the Eastern man, lumberman though he may be, and generally excites his interest in no small degree. Nearly if not quite all of the methods used are peculiar to the section of country lying west of the Rockies, and are so different from those in vogue in the East that only those having made personal inspection have any very well defined idea of just how the thing is done. The character of the country and size of the trees are such that redwood must be handled in an entirely different manner from almost any other timber. The tools used in felling are the ordinary cross-cut saw, usually from 10 to 12 feet in length, ax, wedges, and sledge hammer; but most of the work is now done by saws, the ax being but little used, as the insertion of the wedges serves the purpose of giving free play to the saw. The average height at which trees are cut is about eight feet from the ground, and the reasons for this are numerous. In the first place, a tree with a swell butt would be too large to handle at the butt end if cut off lower down, and even if so done would, in a great many instances, be practically worthless. Then again the tree is less apt to split when felled, and the work can be done much more rapidly, easier, and consequently much cheaper, than would be possible were the tree cut nearer the ground.

The redwood district being very hilly, a good deal of care is necessary in felling the timber, the rule usually followed being to fell a tree up-hill, no matter which way it may happen to lean. The logs are cut from 16 to 24 feet in length, the average being 18 feet, although the bulk of the lumber sold measures only 16 feet. Extra lengths are cut only on special order. As in other sections of the country, logging railways play an important part in lumbering operations, being largely used in transporting logs to the mill, and in many cases to carry the lumber from the mill to tidewater, or the place of shipment. Where the railroad runs into the tract of timber being cut, donkey engines are used to load the logs on the trucks and for other heavy work usually done by horses or oxen.

Another way to get logs to the railway or direct to the mill, and which is used exclusively in this section of the country, is what is commonly known as "snaking." This manner of handling logs is confined to that portion of the country where railways would be either impracticable or impossible. On entirely level ground it does not pay to "snake" logs more than a quarter of a mile, for the reason that it is much cheaper to run a railroad directly into the timber. Oxen are generally used, also in some instances horses are better adapted for the work. From 12 to 14 of these oxen constitute a team, which is handled by one man, and if he be a good driver he can command a salary of $150 a month. At the starting point stands a man known as the "sniper," who sizes up the logs and decides which way they will ride to the best advantage, and they are hitched accordingly one behind the other. The road is prepared beforehand by removing every obstruction, however light, and before many loads have passed over it will be an exact fit for an ordinary-sized log. In preparing the road, should there be the misfortune to strike a piece of level ground, a sort of skidway is constructed, over which hauling is made comparatively easy by a man whose sole business is to go a short distance in advance of the load and scatter a liberal amount of grease on these skidways. Should the road rise the least particle, tanks are placed at short intervals, from which water is obtained and thrown upon the road, thereby relieving the strain upon the team. Six or eight logs are a good load for the average team, and it is really wonderful the way timber can be hauled in this manner. On a round trip taking an ox team say 10 hours, 35 minutes will be about the time required to land the logs at the pond or mill, the balance of the time being taken up with the return trip. Horses will do the work much more rapidly, but in a less satisfactory manner.

Nearly all the redwood is shipped by water, the Pacific Ocean being the only outlet at present, although Sonoma county lumber is shipped by rail; but as the



VESSEL LOADING BY LUMBER CHUTE ON THE CALIFORNIA COAST.

output in that county is limited, and the market is confined to the immediate vicinity, it does not cut much of a figure in the redwood supply. These shipments are, if possible, made direct to point of destination; but when that cannot be done, the product is reshipped at San Francisco or some other large coast port.

LUMBER FLUMES.

What are known as lumber flumes are being used quite extensively in the northeastern portion of this State for the carrying of lumber from the mills to the point of shipment. In the majority of cases flumes are used where other methods of transportation would be impracticable, if not well nigh impossible, but in many instances they are constructed in order to lessen the cost of transporting the lumber from the mill to the railroad station from whence it is to be shipped. On a 40-mile flume, for instance, the cost of transporting a thousand feet of lumber that distance is about $2, when the cost by teams is fully $9. From this it will be seen that in certain portions of this coast flumes are far better, both practically and financially, than any other method of transportation.

These flumes are for the most part all constructed alike, and are known as the V flume, being made of two 20-inch boards, which are battened on the outside wherever a joint occurs, and a piece is laid across the bottom of the flume inside and about four inches from the V joint to prevent boards getting stuck in the bottom and to give a full movement to the water. It is five feet across the top and at a height above the ground depending entirely upon the character of the country it traverses. The support is termed staging, and on top of this framework is a sort of bracket in which the flume proper rests. These flumes sometimes run for quite long distances at an angle of from 30 to 45 degrees, and in order to check the fall of the lumber and prevent it doing any damage a long stretch of level flume always follows one of these falls, and the water resumes its normal velocity. At the lower end of the flume the lumber is thrown out on skidways, and from there loaded on tram cars and carried to point of piling, or to where it is reloaded for shipment. A first class flume can be put into operation for $5,000 a mile, the cost of those now in use ranging from $3,000 to $15,000 a mile. They will carry 100,000 feet of lumber and 50 cords of wood a day without being pushed. For operating one man is required for every five miles of flume, and there is a walk-away constructed along the entire length for their use. The water runs at an average speed of five miles an hour.

CHUTES.

Chutes are a somewhat common affair in this section of the country, especially in and around Mendocino county, where the character of the coast precludes any attempt to load vessels from a wharf. Very few, if any, of these places have any harbor facilities whatever, either natural or artificial, and the abundance of dangerous rocks compels vessels to make fast several hundred feet off shore. The stationary chute generally extends out from 200 to 300 feet, with an apron extension of from 40 to 90 feet. The rocks usually form the foundation for the supports of the chute proper, and if the underpinning is solid, guys are strung from either side of the chute to the shore, to prevent swaying from side to side, but if the foundations are not steady, additional guys are provided leading upward and backward from the main part, and attached to "Samson" posts, thus preventing any great amount of swaying up or down. The apron is made fast to the chute by immense hinges and guys or stirrups extending to strong supports built upward from the main chute, thence downward to a sort of cleat arrangement. These guys control the apron, either raising or lowering it, as the case may be, according to the condition of the water or the movement of the tides. The apron is generally kept at a height of from five to ten feet above the rail of the vessel, thus allowing for the action of the swells in ordinary weather. Near the lower end of the apron is a brake, which is operated by a set of levers. This brake is used to so control the lumber that it can be handled directly from the chute, instead of being first thrown upon the deck. The chute itself is usually constructed of ordinary dimension lumber, put together in the most substantial manner. The apron is necessarily made of somewhat lighter material, but is fully as strong as the main part. From seven to ten men are required to properly handle the lumber from the trucks, or cars, to the deck of the vessel, and 50,000 feet will make a good day's work. A chute costs all the way from $2,000 to $6,000, according to the manner in which it is made and the difficulties to be overcome.

The wire chute is now making a strong bid for first place, more particularly on account of its usefulness in the roughest weather. No matter how strong the wind or how heavy the sea, vessels can be loaded almost, if not quite, as easily as under the most favorable circumstances. Three-inch flexible steel wire is used. This wire passes around a drum, which is operated by a donkey engine, thence out between the vessel's masts, from which it is supported by guys running up to the spars and which are so arranged that the wire can be raised or lowered, as the case may be. The main wire is then extended some distance beyond the vessel and securely anchored. A trip hook is made fast to the wire just above the surface of the water, so that in case of necessity the wire can be loosened instantly. To provide against losing the anchors in such cases, a buoy is attached. The active part of the chute is known as the "traveler," and this carries the load, running up and down the wire by means of a series of wheels. To this traveler is attached a small rope which goes around a drum connected with the donkey engine and used to bring the traveler back to the point of loading. Leading down from this traveler are a set of chains to which are attached two pieces of ½x3 inch iron. This carries the load and is so arranged that by pulling a rope connected with a trip hook, the whole load is at once thrown upon the deck of the vessel. The chain and bar arrangement remains open until the point of loading is reached, when it is again hooked up and another load started on the down grade. The great advantages claimed for the wire chute are that it can be put up in any place where a chute is demanded, a point that cannot be urged in favor of the stationary chute. Another and perhaps the greatest advantage of the wire chute is the fact that it can be extended out any distance required, the leeway given by its peculiar construction allowing it to move with the vessel during stormy weather, a thing which with a stationary chute is impossible. The carrier arrangement will take from 1,500 to 2,000 feet of lumber at a load, and will handle 1,000 railroad ties an hour. Seven or eight men are required to operate the chute up to the dumping of the load upon the vessel's deck. A first-class wire chute can be put up ready for operation at a cost of about $6,000. These chutes have accomplished wonders on this western coast in facilitating the shipment of lumber and ties.

THE REDWOOD TANK INDUSTRY.

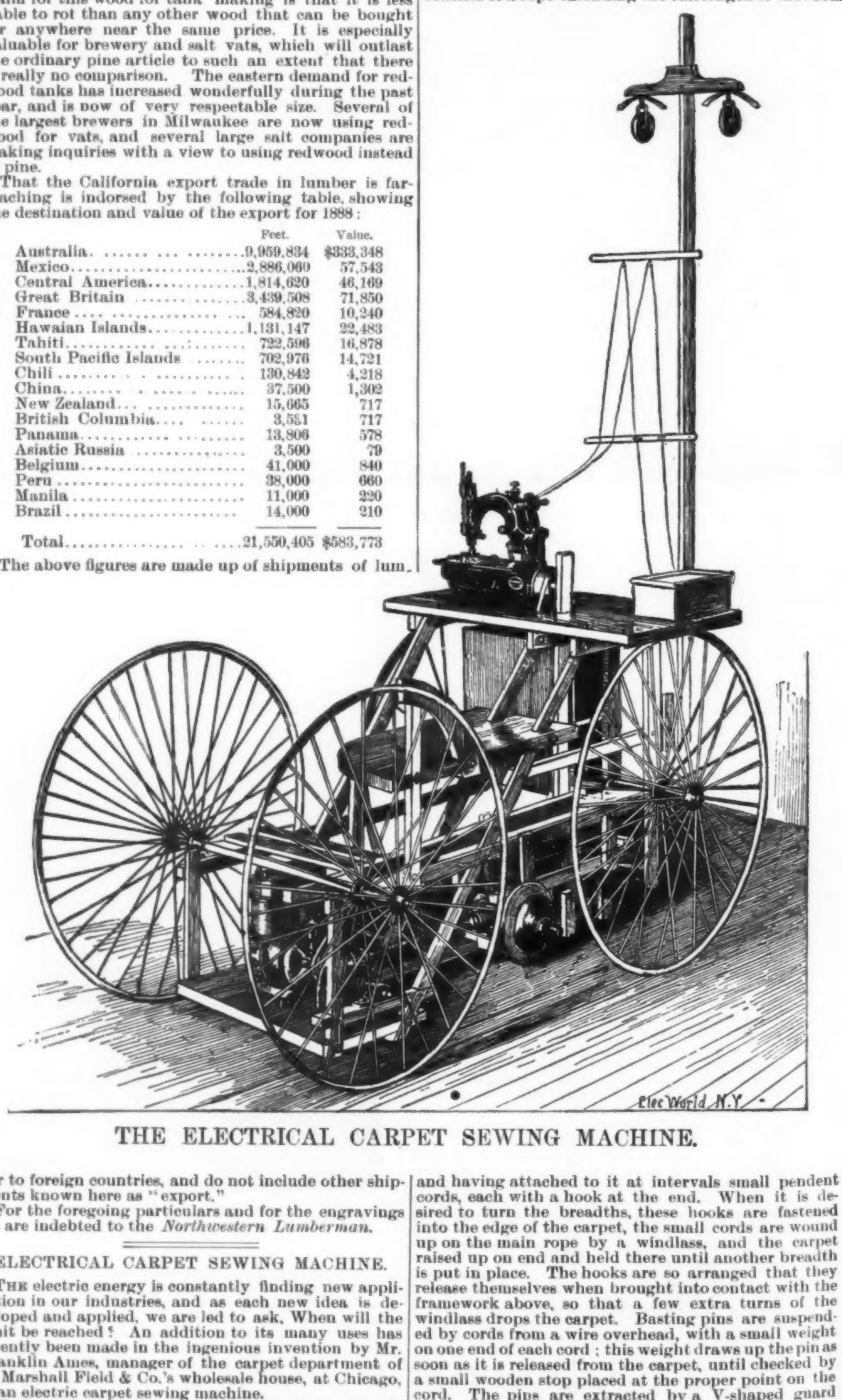
The manufacture of redwood tanks has now become practically an industry by itself. While nearly all the planing mills and every good-sized carpenter shop on the coast pay more or less attention to this particular branch of trade, several of the larger concerns have put in a large amount of machinery especially for this work, and increased their facilities to such an extent as to make it really a business by itself. Some of the men engaged in this trade have made valuable improvements in the machinery used, and in some cases put upon the market entirely new machines that show a vast improvement over those formerly in use. One in particular, the invention of a well known San Francisco man, is so arranged that the stave is made on a form and worked on the outside and both edges at the same time. Nearly if not quite all of the tanks made or used in this State are of redwood. The great claim for this wood for tank making is that it is less liable to rot than any other wood that can be bought for anywhere near the same price. It is especially valuable for brewery and salt vats, which will outlast the ordinary pine article to such an extent that there is really no comparison. The eastern demand for redwood tanks has increased wonderfully during the past year, and is now of very respectable size. Several of the largest brewers in Milwaukee are now using redwood for vats, and several large salt companies are making inquiries with a view to using redwood instead of pine.

That the California export trade in lumber is far-reaching is indorsed by the following table, showing the destination and value of the export for 1888:

	Feet.	Value.
Australia	9,959,834	$333,348
Mexico	2,886,060	57,543
Central America	1,814,620	46,169
Great Britain	3,439,508	71,850
France	584,820	10,240
Hawaiian Islands	1,131,147	22,483
Tahiti	722,596	16,878
South Pacific Islands	702,976	14,721
Chili	130,842	4,218
China	37,500	1,302
New Zealand	15,665	717
British Columbia	3,551	717
Panama	13,806	578
Asiatic Russia	3,500	79
Belgium	41,000	840
Peru	38,000	660
Manila	11,000	220
Brazil	14,000	210
Total	21,550,405	$583,773

The above figures are made up of shipments of lumber to foreign countries, and do not include other shipments known here as "export."

For the foregoing particulars and for the engravings we are indebted to the *Northwestern Lumberman.*



THE ELECTRICAL CARPET SEWING MACHINE.

ELECTRICAL CARPET SEWING MACHINE.

The electric energy is constantly finding new application in our industries, and as each new idea is developed and applied, we are led to ask, When will the limit be reached? An addition to its many uses has recently been made in the ingenious invention by Mr. Franklin Ames, manager of the carpet department of T. Marshall Field & Co.'s wholesale house, at Chicago, of an electric carpet sewing machine.

The machine is mounted upon four wheels of the bicycle pattern, which combine strength with lightness and ease of motion. On the framework, which is suspended from the axles of the wheels, and immediately under the forward axle, is placed a motor—a C. & C. ⅛ horse power, 110 volt incandescent—with its resistance box. The rheostat is situated over the rear axle, and under the shelf that supports the sewing machine.

The sewing machine and the motor are connected to each other by a belt. A slender upright arm supports the trolleys upon two ⅛ inch brass wires that run the entire length of the building, and through which, from the Edison plant that lights a portion of the factory, is supplied the current for running the device. In front of the shelf supporting the sewing machine is a seat for the operator, who controls the action by means of a pedal connecting with the rheostat arm.

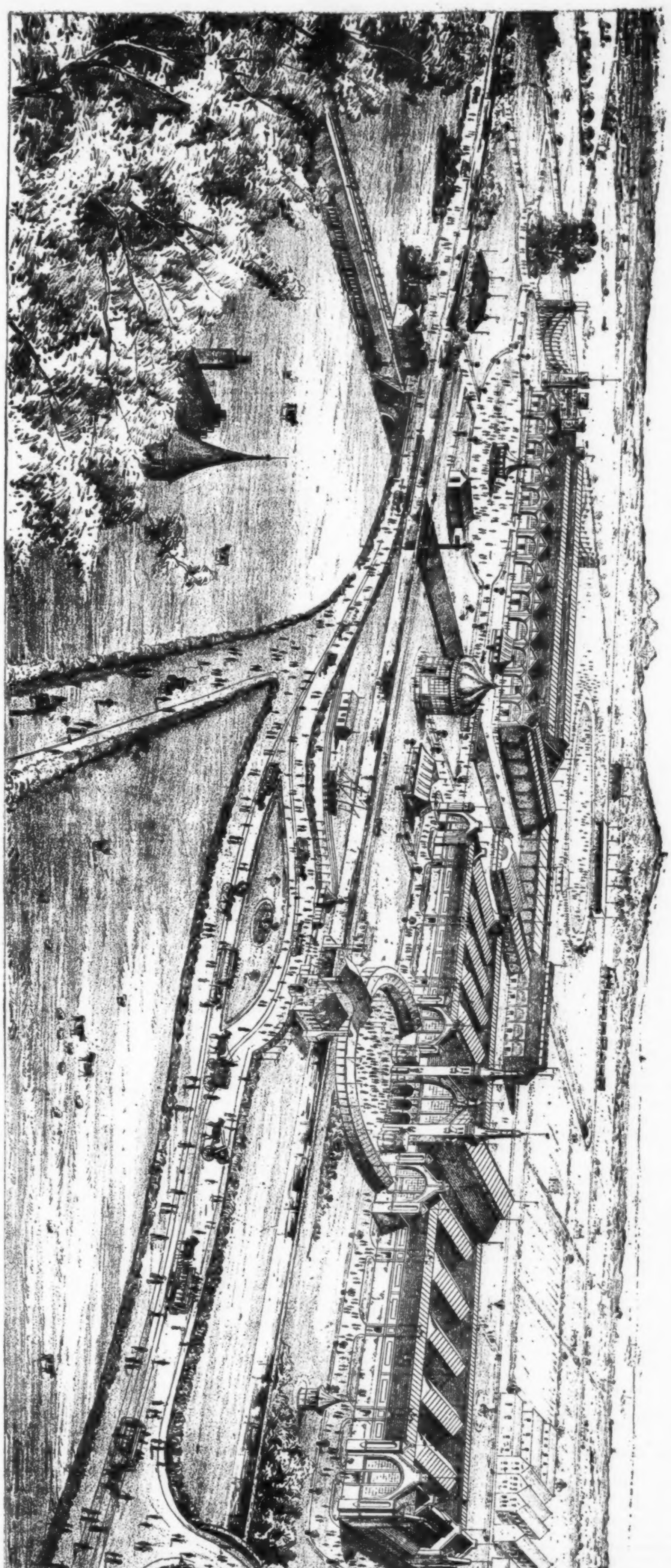
With this pedal is also connected an upright standard, thus rendering it feasible to dispense with a rider and to operate the machine while standing on the floor.

To obviate the necessity of the operator touching the carpet with his hand, a self-feeder is attached in front of the sewing machine.

The machine is placed on tracks at the side of a long table, upon which are placed the carpets to be sewed. In a groove running the entire length of the table are fitted a number of blocks and clamps; the blocks, which may be moved to any desired position in the groove, clutch the ends of the carpet, while the clamps, by means of a screw, tighten and stretch it. In this way a number of small carpets may be placed on the table at the same time, and stretched and sewn at once.

A rigging directly above the table greatly facilitates the handling of long and heavy carpets. This rigging consists of a rope extending the full length of the room, and having attached to it at intervals small pendent cords, each with a hook at the end. When it is desired to turn the breadths, these hooks are fastened into the edge of the carpet, the small cords are wound up on the main rope by a windlass, and the carpet raised up on end and held there until another breadth is put in place. The hooks are so arranged that they release themselves when brought into contact with the framework above, so that a few extra turns of the windlass drops the carpet. Basting pins are suspended by cords from a wire overhead, with a small weight on one end of each cord; this weight draws up the pin as soon as it is released from the carpet, until checked by a small wooden stop placed at the proper point on the cord. The pins are extracted by a V-shaped guard placed back of the needle on the machine.

The practical working of the machine is as follows: The carpets are placed on the table and stretched by means of the blocks and clamps, with their edges flush with the edge of the table, and the basting pins put in at intervals of about a yard. The edge of the



THE EDINBURGH EXHIBITION OF 1890.

carpet is caught by the feeder of the sewing machine, which is level with the top of the table, and the whole machine started along the track parallel with the table, by means of the pedal or the upright. The impetus of the machine draws the basting pin with the V-shaped guard, which strikes a wooden guard placed a few inches above the pin. The rate of traveling speed is graduated to the motion of the needle bar, so that no pulling or irregular stitching occurs.

A small boy can start the machine and either ride on it or walk ahead of it and match and pin the carpet ready for the needle. When it is desired that a different stitch be used, another sewing machine may be adjusted to the carriage with but little trouble.

The immense saving of labor that is accomplished by this machine is apparent when a comparison is made between the amount of work done by it and an ordinary operator. By hand, about 25 yards of carpet can be sewn in a day; by this machine, about eight yards a minute. The inventor proposes so to arrange that two machines may be placed, one following the other, on the same track, and both operated at the same time. Thus ingrain and Brussels carpets may be sewn at the same time, and the amount of work done be doubled. Mr. Ames claims that, with six boys to operate two machines, an amount of work equal to that now accomplished by 300 girls can be turned out. The seam made is superior to any that can be made by hand, excelling in evenness and flatness.—*Electrical World.*

THE EDINBURGH EXHIBITION.

WE give a general view of the buildings and grounds of the Edinburgh exhibition, opened on the 1st of May, for which we are indebted to *Industries.*

The total area now inclosed is about fifty acres. There are eight and a quarter acres of the buildings proper, of which the main building accounts for over four acres, and the machinery hall for about two and a half. The space allotted to exhibitors amounts to nearly a quarter of a million square feet. Compared with recent exhibitions, the present may be said to be intermediate in size between that held in Edinburgh in 1886 and that held in Glasgow in 1888. In several respects, notably in the display of general machinery and the extent and variety of out-door exhibits and amusements, it will probably surpass any exhibition ever held in the provinces. There is an electric railway, a line on the telpher system, the Smith ship railway, and the "Chemin de Fer Glissant" from Paris. Later on we intend to devote some space to their description.

AN ENTOMOLOGIST'S EXPERIENCE.

By T. G. H.

EARLY one Sunday morning in the latter part of July, 1880, I left my home in the northern part of a Hudson River town, equipped as usual with the paraphernalia for collecting butterflies, passed over the hills, down the hillside toward a valley stretching to the east of the town.

Everywhere quietness reigned supreme. Leaving the dusty country road and jumping over a fence, I found myself in a patch of wood, through which I wended my way to reach an apparently deserted farm, as the zigzag wooden fences separating the several fields were mostly down and rotting away, while the ground looked as if it had not been turned over by the plow for many a year, and weeds were growing everywhere.

Pausing for a moment at the edge of the woods, I critically surveyed the country before me and noticed, about a half mile away, a dilapidated farm house and a still worse looking barn leaning on the hillside, while farther down in the valley a small stream, lined here and there with shrubs, wended its way. The house was apparently inhabited, as smoke passed out of the chimney and rose lazily up into the air in full harmony with the whole surroundings. From the farm house a lane extended down and over an old plank bridge across the brook to join a public highway stretching along the opposite side of the valley.

In my immediate neighborhood I could discern but a few butterflies, but down toward the lane and bridge the air seemed fairly alive with them, so that I did not rest long at my post of observation, although the latter had an unspeakable fascination for me, probably because such lonely places, far away from the noisy city and the toil of human beings, easily led one to meditate over his own doings, and to listen to the throbs of the beating heart and soul, as I have often experienced when pausing in my tramps through the beautiful nature of the Almighty.

Before long I was down and among the swarm of insects, and busily engaging myself in gathering the many rare specimens which, queer to say, did not alight on the wild flowers, although the latter were in great abundance, but they only seemed to chase each other in the air, but always as coming from and going toward the lane, near which, I noticed on following a very rare specimen, they disappeared. Stepping up to within a few feet from the lane, I discovered a ditch running along one side of the lane from the barn to the brook.

To my great astonishment, the sides of the ditch, through which slowly passed a muddy barn-yard liquid, were literally covered with butterflies sucking the nasty stuff.

I went to work with a will, and at first I used the net, but as I soon found out that they did not stir even when covered with the net, I laid the latter down and carefully picked the insects off the ground with thumb and forefinger and placed them in my poisonous cyanide bottle. What was the strangest of all, the insects offered no or very little resistance, but as I was too busily engaged at the moment gathering in as many as I could, I did not inquire as to the cause of all this, leaving it until I had my full share. Suddenly I was somewhat startled by a rough voice saying, "What are ye doing there, stranger?" Rising from my stooping position, I almost struck my head against the barrel of a shotgun directly pointed at me and firmly held in the hands of an evil-looking individual standing in the lane. After recovering my breath I stammered, "I beg your pardon, sir. I am catching butterflies for my collection. It is my hobby." The latter I added with something which I intended for a smile, although I felt like anything but smiling at that moment.

The individual looked incredulously at me and the proofs of my assertion I held in my hand. Finally with

an oath he ordered me off his place, and never to trespass again or he would send a bullet through my humble form at first sight. I felt rather uncomfortable, but did not wait for a second warning, and retreated mighty lively down the lane and over the bridge toward the highway, still begging his pardon and saying almost all sorts of foolish things about being an entomologist, and doing this only for science sake; benefiting his farm by killing the parents of the rapacious caterpillars, etc.

I went straight home, and not in the best of humor either, although I had a consolation in the valuable specimens contained in my bottles. On my way home I reasoned with myself. I was satisfied that my doings on the farmer's fields were perfectly harmless. I ruined no crop, as there was none there to be ruined; so what on earth had caused that man to treat me so roughly? The more I reflected, the less satisfaction I found, and I finally dismissed the subject.

Then I thought of the mysterious ditch with the hundreds of butterflies in it. I knew that ordinary barn yard liquid has a slight attraction to but a few kinds of butterflies, but those which I caught did not belong to them. On reaching home I examined authorities without getting any light on the subject. I pondered over this the following day, and finally made up my mind to investigate the matter the next Sunday regardless of the shot-gun. The explanation, however, came before that.

Toward the end of the week the town was greatly surprised by the arrest of "moonshiners" in their immediate neighborhood. An illicit still was seized by revenue officers in an old farm house, and the parties were arrested. It was rumored at the time that they had filled the whisky into barrels marked "vinegar," and shipped the same under this false flag to New York. The moonshiner, no doubt, was my friend with the shot-gun, and the ditch in which I found the butterflies was used to run off the residue of the still.

My specimens had evidently been on a spree when I caught them.

NOTE: In reply to an inquiry regarding the seizure of the illicit still, Mr. G. M. Wilson, Deputy Commissioner of Internal Revenue, kindly furnished the following particulars:

"The seizure was made July 29, 1880, of an illicit distillery and other property on a farm, three miles north of —— It was described as a vinegar factory. A man giving the name of John Doe was arrested as the party in charge."

THE ESTIMATION OF MINUTE QUANTITIES OF GOLD.*

By Dr. GEORGE TATE, F.I.C., F.C.S., Principal at the College of Chemistry, Liverpool.

AT a recent criminal trial, wherein experts referred frequently to thousandths of a grain, Mr. Justice Stephens ventured the opinion that the mind untrained in the observation of minute quantities could not comprehend so minute a fraction of what many conceive as being the least ponderable quantity.

As a person that is accustomed to weigh or handle fractions of an ounce, or possibly only of a pound, cannot place before you the most approximate estimate of a grain, so in like manner a chemist, accustomed to weigh only to the hundredth of a grain, would generally fail to form an approximate estimate of a thousandth of a grain. I say this since, although the wonderfully fine workmanship of a good assay balance permits of the estimation of a thousandth of a grain, still such minute portions of chemical substances are commonly estimated by the observation of an eye trained to observe color, opacity, or other comparative physical effects brought about by the action of reagents chosen according to the nature of the substance brought under analytical tests. It is virtually only by comparison, by having some bulk, color, or appearance as a standard of quantity, that the eye can estimate weights either large or small. I propose endeavoring to show you how minute a quantity of certain substances is capable of recognition; and to show how, by suitable means, such minute quantities as the one ten-thousandth, or even the one hundred-thousandth of a grain, may be estimated with such accuracy and certainty as I think will satisfy the most captious mind.

For the recognition of these minute quantities, what are termed color reactions are certainly the most sensitive, and therefore most extensively employed by chemists.

I have formed an estimate of the sensitiveness of certain of these reactions, so that their capabilities might be demonstrated to you. I have here portions of brucine, strychnine, iron, and copper in the form of salts, obtained by subdivision of dilute solutions of known strength; these portions contain therefore known quantities of matter. Each of these quantities gives with specific reagents distinct color reactions, indicating, with more or less conclusiveness, the presence of the respective substances.

These powers of such color reactions, for the recognition of minute quantities of certain chemical bodies when isolated in a fair state of purity, are unsurpassed, saving by the powers of the microscope and spectroscope. When applied, however, to quantities extracted from an ounce or more of organic or inorganic matter, these color methods would fail to form more than the most approximate estimate of the ten-thousandth of a grain, and could enable me to only state (not in every case with scientific precision) that some minute trace of the substance was present in the ounce weight of matter.

The microscope, however, now an instrument with which a scientific or analytical chemist cannot dispense, can, in many cases, recognize and identify with conclusiveness far less than the millionth of a grain of chemical matter, and estimate its weight with a fair degree of accuracy. I have, during the past year, had frequent occasion to estimate minute quantities of gold, imponderable upon the best assay balances, and have lately proved, to my satisfaction, the general accuracy of my method of working. I purpose demonstrating to you this method of estimating gold, and to lay before you facts and figures that I trust will convince you of the accuracy of my work. It may appear to some a "fancy" method of no practical utility, but when we consider the needs of the gold prospector, and how any method for enhancing the accuracy of estimation lessens the labor involved in assay or chemical test, any such process is at least worthy of trial.

The method I have elaborated is virtually the system of measurement of gold, after fusion and when in an approximately spherical form, described in Plattner's work on the blowpipe and in other works on assaying. As there described, the weight of a bead of gold is estimated from its diameter, obtained by placing the bead above a divided scale of two divergent lines. The method is no doubt familiar to all assayers, and I think all that have tried it will agree with me that with small beads of gold two independent observations may differ often by 1,000 per cent. I have found that by employing a compound microscope to largely increase the apparent size of the prills or beads, and an eyepiece micrometer as a scale, the measurement method becomes one possessed of scientific accuracy and of powers far beyond that of the very finest balance ever constructed. To convince you of this, I have here beads of gold, each respectively the $\frac{1}{100}$, $\frac{1}{1000}$, $\frac{1}{100000}$, $\frac{1}{1000000}$ of a grain, which I may guarantee to be accurate to those weights within 10 per cent., even in the case of the smallest weight.

The magnitude of the smallest of these weights may be better conceived when I state that it is quite invisible to the unaided eye, and that one thousand of them would be required to distinctly turn a delicate assay balance, and that the error in estimating the weight of these thousand beads could, only by the most elaborate system of weighing, be made to fall within 20 per cent.

These beads or prills are what I may term standard weights, and have been accurately measured with the microscope; so that by comparison with these, the weights of gold prills such as may be obtained as the result of an assay may be accurately estimated.

Preparing the Standards.—To obtain these standard beads I take a weight of pure gold (*e.g.*, 0·1 grm. or 1 grain) that can be accurately weighed within 1 per cent. on an ordinary analytical balance, or within an error of 0·1 per cent. on an assay balance, and alloy it with about 100 times its own weight of pure lead, either by fusion upon a scorifier or in a small crucible. After weighing the alloy obtained I calculate what weight of it contains the quantity of gold I require for the standard bead or prill (*e.g.*, 0·1 m. grm. or 0·001 grain, according to the system of weights adopted).

For the lead, ordinary assay lead or the lead obtained from litharge by reduction may be employed for gold lead alloys of one per cent., without introducing an error of more than one per cent. in the weight of the bead obtained from them.

This slight error arises from the presence of a trace of silver in so-called pure lead or in litharge lead; this error becomes appreciable when one-tenth per cent. alloys of gold are prepared, *e.g.*, for the purpose of obtaining the standards, the one-ten-thousandth, and the one-hundred-thousandth grain—in such cases special lead must be used.

Having weighed off several, say ten, portions of the necessary weight of alloy to give the desired gold prill, they are separately cupellated on small bone ash cupels, either before the mouth blowpipe or in the muffle.

By thus heating the alloy in an oxidizing atmosphere, the lead is eliminated, passing away from the gold as fused litharge, which is absorbed by the porous bone ash of the cupel. If the blowpipe is employed, a strong heat should be brought to bear upon the residual gold, so that when the flame is withdrawn, the prill remains fluid for some few seconds and has time to acquire an approximately spherical form before it solidifies. Ten such beads, if each of the thousandth of a grain or of the tenth of a m.grm., together form an appreciable weight, and can hence be together weighed to ascertain if the average weight is correct. The following is an example:

Five portions of gold lead alloy, each calculated to contain one-hundredth of a grain (0·65 m.grm.), were cupellated; the five gold prills were detached and together weighed on an assay balance.

5 prills weighed..................	0·050 grain.
Average weight of each prill.......	0·010 "

These beads measured (with magnifying power that I will refer to as No. 1, and by the method later described) respectively,

21·3, 22, 21·5, 21·5, 21·5,

giving an average diameter for a bead 0·01 grain in weight of 21·5 divisions of the scale.

In a similar way were obtained the empirical measurements of prills.

0·1 and 0·05 m.grm. (0·00154 grain and 0·00077 grain); the diameters of these averaged 11·1 and 8·7 divisions.

The above standard prills are those that have been chiefly employed for the estimation of the weights of gold obtained in the experiments to be later described.

For the preparation of the standards of smaller weight, *e.g.*, the one-ten-thousandth of a grain, a gold lead alloy containing about 0·05 per cent. of gold was used, the lead being exceptionally free from silver, and obtained from litharge in the following way:

A pound of litharge was mixed with about 5 grms. or 75 grains cream of tartar, and fused in a capacious crucible in two or three portions at a time. By this about an ounce of lead was reduced from the oxide, the residual oxide being thus partially freed from the trace of silver invariably found in the commercial litharge.

The residual litharge was pounded, again fused with the above weight of tartar, thus again separating a part of the lead and of the trace of silver. With the remaining oxide, the partial reduction was again repeated, and, finally, after these three purifications, the rest of the oxide was mixed with excess of cream of tartar and some fine charcoal powder, and fused so as to reduce out all the lead.

To test this lead 50 grms. or 770 grains were heated on a scorifier in an oxidizing atmosphere, so as to reduce the weight of metal to 10 grms. (150 grains); this, on cupellation, gave a distinct trace of silver. I therefore decided to oxidize, by scorification, two or three ounces of this fairly pure lead, collected about half an ounce of oxide (still leaving a large excess of lead in the metallic state), purified it by partial reduction, and finally fused with excess of tartar. The lead produced by this final operation was of such purity that I was enabled, by alloying it with 0·05 per cent. of gold, to obtain standard prills of gold 0·0001 grain (0·0065 m. grm.), 0·00001 grain (0·00065 m. grm.), and 0·000001 (0·000065 m. grm.), perfectly free from silver, and estimated by comparison with the higher standards to be exact within an error of less than ten per cent. In other words, the prill of gold that is now under a high power of the microscope is the millionth of a grain, and exact to the one ten-millionth of a grain. It has the color of pure gold, is apparently perfectly spherical in form, and has a diameter, in actual measurement, according to the mean of a large number of observations, of 0·00075 inch. Assuming this minute bead of gold to be a sphere, its volume would correspond to a weight of gold equal to 0·00000107 grain.

This close agreement between the weight of the gold prill and the weight of the gold in the lead alloy taken for cupellation proves how minute must be the loss of gold when cupellated with lead.

The average absolute diameters of the standard prills or beads have been calculated, and are given in the following table. In the column D are given the amounts by which spheres of gold, of the specified diameters, would exceed the weight of the prills. The specific gravity of the gold has been taken as 19·2.

Weight of standard in grains.	Diameter in thousandths inch.	Relative cubes.	D Per cent.
Hundredth	15·81	9·17	+ 0·4
Thousandth.............	7·55	1·	+ 9
Ten-thousandth	3·63	0·110	+22
Hundred-thousandth....	1·61	0·0097	+ 6
Millionth................	0·75	0·00098	+ 7

The Measurement.—For the measurement of beads ranging in weight from the hundredth to the ten-thousandth of a grain (or from 0·05 to 0·005 m. grm.), the most convenient magnifying power is that afforded by a microscope fitted with a ½ inch objective and B eyepiece; although most of the results here recorded have been obtained with a one inch objective, and the microscope tube drawn out so as to give a total length of 12 inches. Some of the smaller beads (*e. g.*, $\frac{1}{1000000}$ grain) have been measured with ¼ and also ⅛ inch objectives, by which the accuracy of the measurements has been greatly enhanced.

A convenient stage is one enabling a steady motion to be given to the glass slide upon which the bead is placed, so that the latter may be quickly adjusted to the scale in the eyepiece. A stage moving by rackwork is a great luxury, and enables measurements to be rapidly made.

The micrometer that I have employed is photographed down to ½ inch from a scale ten inches long (an old thermometer scale upon white porcelain) and has about 80 divisions in the half inch. The glass upon which the positive is taken is cut into circular form and then dropped into the eyepiece upon the diaphragm, where it is in the focus of the upper lens.* This form of micrometer is superior to any engraved scale, being distinctly visible when the stage is illuminated, and both it and the object upon the stage can be, at the same time, brought into the focus of the eye. It is a convenience if the eyepiece fits loosely in the tube of the microscope, since then a slight turn or movement of the former can bring the apparent edge of the bead or prill, as viewed through the instrument, accurately to a unit division of the scale.

Having a gold prill (say upon the cupel), have ready a dry glass slide, plain or having a small cell, moisten the point of a knife, gently touch the bead with it until it is loosened; the bead generally adheres to the point, and can be transferred to the glass slide. When the prills are required to be kept for reference, they may be mounted in a cell formed on the glass by gumming one or more thicknesses of paper, in which small holes have been cut, covering with a circle of glass, and fixing the latter in position by gummed paper.

The bead is lighted from below and brought into the focus of the microscope; it then appears as a black circle with well-defined edge. To measure the diameter, the stage is moved until the head apparently coincides with the micrometer scale; the units, and approximately the 1-10ths that the bead measures, is then read upon the scale. It is well to take the measure in two directions at least, by turning the eyepiece, and with it the micrometer, through 90°; an average of the measurements is then taken.

The beads are slightly flattened at the point where they have rested upon the cupel, and when resting upon this flattened surface appear spherical in form. Since the flattened surfaces are not always in view in taking the measurements of diameters, they are, when visible, best left out of consideration.

Knowing the measurement of a bead of standard weight, that the prill can be calculated upon the assumption that both are approximately spherical, and therefore that the weights of the two masses are proportionate to the cubes of the diameters.

Example:—A prill of gold obtained as the result of an assay measured, under the power before recorded, 12·5 divisions.

The average diameter for 0·01 grain is 21·5 divisions, hence the weight of the prill is $21{\cdot}5^3 : 12{\cdot}5^3 :: 0{\cdot}010 : x$

$$x = \frac{0{\cdot}01 \times 12{\cdot}5 \times 12{\cdot}5 \times 12{\cdot}5}{21{\cdot}5 \times 21{\cdot}5 \times 21{\cdot}5} = 0{\cdot}00197 \text{ grain,}$$

or approximately 0·002 grain.

If the comparison is made against the average diameter of the 0·1 m. g. beads, the weight would be estimated as 0·143 m. g., or 0·0022 grain, showing a difference in estimate of 10 per cent. I would prefer to accept the estimate made against the lower standard, since it more closely approaches in size, and therefore in form, to the assay prill. Considering, however, that this difference is in weight only 0·0002 grain, and that a balance would differ at least to 0·0005 grain in two observations, the above example will show that with the thousandth of a grain the method of measurement is superior in accuracy to that of weighing. With the aid of a table of cubes the calculations can be quickly performed.

Where the ten-thousandth of a grain of gold is to be measured, before attempting to detach the prill it is advisable (for fear of loss) to measure it while still upon the cupel. For this purpose place the cupel itself on the stage, illuminate the surface from above, focus and measure as accurately as possible. Measurement in reflected light commonly gives a lower estimate than

* A paper read before the Liverpool Polytechnic Society, November, 1889.

* Mr. Knott of Elliott Street, Liverpool, photographed these micrometers, and can fit them to any eyepiece.

by illumination from below, owing to the difficulty of seeing the edges of the strongly reflecting bead. After a little practice even the 1-100,000th of a grain can be detached from the cupel and mounted in a cell. The risk of losing the prill is chiefly in detachment.

Outline on the Method of Assaying.—Taking the case of quartzeous gold ores for the sake of illustration, the ore, after careful sampling and pounding into a fine state, is sifted. Any metallic particles that remain on the sieve are collected and weighed. The finer ore being also weighed, proportionate parts of the two are weighed off for assay. Convenient quantities for assay are from 100 to 1,000 grains, or from 10 to 100 grms., according to the richness of the ore and the degree of accuracy required in the results. By adopting the measurement system, accurate assays may be performed upon much smaller quantities than when the gold is weighed. In fact, fairly accurate and concordant assays of rich gold ores, sufficiently accurate for the purposes of a prospector, have been obtained from one grain only of material. As in all analytical tests, two or more portions should be submitted to assay. Where the method of fusion with litharge in a crucible is adopted, the weighed portions are mixed with flux, litharge, and some reducing substance, and heated to complete fusion in a good clay crucible. Convenient proportions are, in the case of quartz ore (fairly free from pyrites): Ore, 100 parts by weight; litharge, 200 parts; soda ash, 200 parts; and cream of tartar, 4 to 5 parts. On fusion about one tenth or eighth of the litharge is reduced, the remaining portion serving, with the soda, as a flux for the siliceous matter of the ore. With ores containing pyrites or other sulphides, the tartar may require to be reduced in amount or even altogether omitted, since the sulphur of the pyrites acts as a reducing agent toward the litharge. A good rule to observe is to obtain a large excess of litharge in the slag, and at most 50 parts of lead from 200 of litharge. During the fusion, the lead that forms picks out or alloys with the gold, collects at the bottom of the crucible, and there, when the ore is completely fused, receives such particles of gold that have escaped the action of the globules of lead, and that tend to fall through the fused mass of slag. To further promote the separation of the gold, a little tartar mixed with litharge may be thrown or sprinkled upon the surface of the fused mass in the crucible, so as to form minute particles of lead, which, in falling to the bottom, no doubt serve to perfect the collection of the gold. The contents of the crucible are poured into a mould, the slag again fused with a small quantity of tartar, and again poured.

The lead produced by these two operations contains, according to test experiments described later, practically all the gold of the ore,* together with the silver natural to it and to the litharge, also traces of other reducible metals, such as copper, if the ore contains such.

This alloy is heated upon bone ash supports or cupels in an oxidizing atmosphere, until all oxidizable metals are removed and absorbed as oxides by the porous bone ash; an alloy of silver and gold is then left as a bead or globule.

The Parting and Fusion of the Gold into a Bead.—In the estimation of minute quantities of gold, with which this paper only deals, remove the silver-gold alloy from the cupel and place it in a small clean porcelain crucible; add one, two, or more drops of pure nitric acid (diluted with one half its bulk of distilled water), according to the amount of alloy, and gently heat upon wire gauze by means of a small flame until all action appears to have ceased. The Bunsen burner or spirit lamp should be held in the hand, so that when violent ebullition commences, the heat may be quickly withdrawn.

When the silver is in appreciable excess of the gold (2½ to 1) the former metal dissolves, leaving the gold as one black spongy mass, or as a number of particles. In the latter case the particles may be made to cohere by slightly turning the crucible between the fingers and causing them to touch. About half fill the crucible with distilled water, allow the gold particles to settle, and then decant off the fluid by pouring against the finger used as a decanting rod. The contents of the crucible should be carefully watched during this decantation, so that no gold particles are allowed to escape. Fresh water is then added, and the liquid again decanted. If the silver has been appreciable in amount, the washing may be repeated a second or third time.

The crucible, and with it the gold, is dried on an iron plate or wire gauze, kept warm by a small flame. If a strong heat is applied, the metal diminishes in bulk, acquiring the yellow color of gold, and cannot then be so readily removed. Cut a small piece of lead (as free as possible of silver, and weighing about half a grain) with a smooth flat surface. Hold the lead upon the point of a penknife, and press the bright surface upon the particles of gold; the latter generally firmly adheres to the lead. Transfer the lead, and with it the gold, carefully to a small bone-ash cupel. The gold will then be on the under surface of the metal, and protected from loss during the next operation of cupellation.

This cupellation is performed in the manner described for the preparation of standard prills, or by placing the cupel containing the metal in the muffle of an ordinary muffle furnace, or in a miniature furnace that can be constructed for the purpose. The prill of gold left after cupellation should have a bright golden color and rounded form. If not round it can be again picked up on a piece of lead, and again cupellated. The measurement and estimation of the weight of the prill is performed in the way previously described.

The cupels that are employed by myself are made from very fine prepared bone ash, and are about ⅛ in. in height and ⅜ in. wide. The mould was fashioned from an old file handle from which the brass ring or ferrule of the above dimensions was removed; on the round end of the wooden handle was fixed a round-headed brass nail such as are used for ornamental purposes; the end of the handle from which the ring had been removed was slightly lessened in size, so that it readily slipped into the ring. To prepare a cupel, stiffen the bone ash with water, press some into the ring mould, fashion a cup-shaped depression with the rounded end of the handle, and then force out the moulded ash with the other end. Keep the cupels for some time in a warm place, and then heat them for a few minutes in the muffle furnace. If the bone ash has been originally fine, such cupels are fairly strong, freely absorb fused litharge, and are even, when viewed under the microscope, smooth in texture and much superior (for cupellations in miniature) to the ordinary cupels employed for assaying, since among the irregularities of these latter, minute gold prills are very often lost. Moulds of various sizes can be made in the above way; the moulds also serve for making miniature clay scorifiers, and by a little alteration of the moulding rod, for clay crucibles suitable for miniature assays.

A miniature muffle furnace may be constructed out of two plumbago crucibles, 4 or 5 inches high, to serve as the furnace body, and a short length of porcelain or fire clay tube of 1 to 1½ inch bore to serve as a muffle. By means of a penknife, cut the bottoms from the two crucibles. One crucible is supported mouth upward in the ring of a retort stand, and upon the mouth (in semi-circular depressions that have been cut with a knife) is placed the porcelain or clay tube; the tube is then covered with the other crucible, cut in the lip in the same manner as the under one. The furnace as thus constructed is open at the top and bottom, and tapers down and up from the muffle. The muffle is heated by a Fletcher or other convenient blowpipe from the lower orifice, and with a good blast can be brought to the temperature necessary for cupellation in two or three minutes. Doors for the two ends of the tube may be constructed out of the crucible bottoms. In place of a tube, a small sized triangular crucible, in the bottom of which a hole is drilled, will serve as a muffle.

When the gold obtained by parting appears to be less than the thousandth of a grain, it is generally advisable to cupellate with lead (so as to obtain the prill) in a muffle, rather than by the blowpipe, since the cupel is then less liable to crack, and no risk is incurred of loss of the gold by its being mechanically carried away by the force of the blast from the blowpipe.

Utility and Accuracy of the Measurement Method.—The following considerations will point out the utility of the application of the microscope to the assaying of gold ores and auriferous metal.

An ore yielding on assay 6 dwts. 12 grains of gold per ton (or 0·001 per cent.) is generally an ore that pays for working, yielding a slight margin of profit. Where the assay balance is employed for weighing the gold obtained by assay, at least 500 grains (or 32 grammes) would be required to be assayed so as to estimate the proportion of metal per ton within an error of 1 dwt. Such an ore in this quantity would yield on assay 5 one-thousandths of a grain. The gold from the same, or even one-half of the quantity of ore, could be estimated with one-half of the above possible error by means of the microscope. Upon 10 grains, if they could be trusted as being a representative sample of the rock, yielding an unweighable quantity of gold, a prospector could quickly estimate the proportion of gold within an error of 1 dwt. per ton. In other words, a skillful manipulator of the blowpipe, with the aid of a microscope, could, with comparatively few and simple apparatus, quickly perform rough assays of rock or trace the yield of gold in different parts of a bearing lode, or by comparative tests obtain valuable indications of the genuineness, or otherwise, of auriferous rock when taken from the mine.

By working upon 1,000 grains of rock or metal (65 grammes), gold in the proportion of only 2 grains per ton has been obtained and estimated by this method of measurement—the estimate erring presumably only to the extent of 20 per cent.; since the author has found that the one ten-thousandth of a grain (0·0065 m. gramme) can be parted even from many thousand times its own weight of silver with a loss of gold less than the percentage above mentioned, and that even the millionth of a grain of the metal still leaves some proportion after parting from silver and collection by lead.

Needless to say, the litharge employed for the assay by fusion should itself be free from any such proportion of gold as might entirely nullify the accuracy of the assay conducted with its aid. A method for the purification of litharge has been previously described.

The commercial litharge employed for my experiments yielded (by assay of 2 lb.) gold in the proportion of only one-hundredth of a grain per ton.

No doubt the most scientific worker is apt at times to overrate the powers of any method of analysis or estimation that has been found by him to give accurate results.

It is impossible to free the mind from some trace at least of prejudice. I am glad, therefore, to be able to give more or less independent evidence of the extreme degree of accuracy to which gold estimations may be carried by means of the microscope. This opportunity has been afforded me by a skeptical friend—Mr. A. H. Knight—who has had considerable experience in gold assaying, but who, I think, will in future, in necessary cases, weigh his gold with the microscope.

Mr. Knight introduced, by means of an alloy of lead, gold, and silver, known quantities of gold into assay lead, and supplied me with six portions of alloy, in each of which he required me to estimate the total gold.

In each case I cupelled and parted the gold from the silver, collected and weighed by measurement in the manner described. The following are my returns, side by side with the calculated quantities of gold assumed to be present, on the assumption that Mr. Knight's alloy of gold was uniform throughout:*

Sample No.	Estimated weight of gold (G. T.) Grain.	Actual quantity of gold. (A. H. K.) Grain.	Error in weight.	Error in per cent.
1	0·0052	0·00499	+0·00021	+4
2	0·0100	0·00991	+0·00009	+1
3	0·0026	0·00242	+0 00018	+7
4	0·0012	0·00132	—0·00012	—8
5	0·00066	0·000678	—0·000018	—3
6	0·00028	0·000244	+0·000036	+14

In actual weight, the greatest error is approximately two one-ten-thousandths of a grain of gold (or 0·013 m. g.); the smallest error is approximately two one-hundred-thousandths of a grain (0·0013 m. g.).

Since it might be urged against the utility of the microscopic estimation of gold that the ordinary crucible or "pot" method of assaying ores might be incapable of enabling the assayist to isolate the one ten-thousandth of a grain, or that the losses incidental to cupellation, parting, collection, and fusion of the gold were together in excess of that weight, I have conducted a large number of experiments which tend to prove that, with care, exceedingly minute quantities of gold are capable of isolation, and that the percentage loss of metal is extremely small. A few of these experiments are here recorded.

Distribution of Gold in Lead Alloys.—To determine that my method of obtaining standard gold prills from lead alloys was not appreciably affected in accuracy by want of uniformity in the distribution of the gold throughout the lead, I prepared an alloy of gold with assay lead. After allowing the ingot of metal to slowly cool, portions of 2 grammes (30 grains) were taken from the top, center, and bottom of the ingot, and separately assayed for gold.

The prills of parted gold measured respectively 15·9, 16·4, and 17·0 divisons, indicating 0·30, 0·32, and 0·36 milligrammes, or 0·0046, 0·0049, and 0·0053 grain of gold. When the gold-lead alloys employed for preparing standard prills are well flattened, one may hence feel assured of the uniformity of the alloy.

Loss in Parting.—Gold prills varying from 0·0001 to 0·002 grain in weight, according to measurements with the microscope, were alloyed with various proportions of silver, parted from this metal, and then collected and fused into beads. In the majority of cases the prills were repeatedly alloyed and parted.

Parting tests A and B:

Gold prills.	Measure (¼ inch).	Weight in milligrms.	Parting loss in milligms.
Original	43	0·0772	
1st parting	43	0·0772	nil.
2d "	40	0·0621	0·0151
3d "	37	0·0491	0·0130
Original	43	0·0772	
1st parting	41	0·0670	0·0102
2d "	40	0·0621	0·0049
3d "	36	0·0452	0·0169
4th "	35·8	0·0445	0·0007
5th "	34·5	0·0388	
6th "	35	0·0416	0·0029

Total loss in 3 partings, A..........36 per cent.
" 6 " B.........46 "
Average loss for 1 parting, A ......12 "
" 1 " B....... 8 "

Parting tests C:
Original gold ....0·000100 grain.
Gold after 1st parting..0·000088 "
Gold after 2d " ..0·000072 "
Loss in 2 partings.....0·000028 " or 28 p. c.

Parting tests D:
Gold taken...........0·000100 grain.
After cupellation with
large excess of silver
and 100 grains lead,
and parting twice..0·000075 grain.
Loss in 2 partings ....0·000025 " or 25 p. c.

In the above tests the silver was in each case in excess of the quantity necessary for parting, but had not been weighed.

In the following series, silver, in the form of a lead alloy, was added in definite amount.

After each parting in these two series the silver solution was filtered through good filter paper. The paper was finally assayed for gold, and found to contain 0·193 milligramme gold, showing that 0·0196 milligramme of gold was presumably in the acid solution, and that one-half of the loss only was due to minute particles of float gold being mechanically carried away in the washing.

Parting tests E:

Parting No.	Gold measure 1 in. objective.	Parted from silver. Milligrms.	Weight of gold. Milligrammes.	Loss in Weight. Milligrammes.	Loss per cent.	Ratio gold: silver.
—	8 75	—	0·0491	—	—	—
1	8 75	0·25	0·0491	0	0	1 : 5
2	7·9	0·25	0 0350	0·0141	28	1 : 5
3	8·0	0·25	0 0374	0	0	1 : 7
4	8·0	0 50	0·0374	0	0	1 : 13
5	7·5	1·0	0·0309	0·0065	17	1 : 27
6	6·9	1·0	0·0239	0·0070	22	1 : 30

Parting tests F:

Parting No.	Gold measure 1 in. objective.	Parted from silver. Milligrms.	Weight of gold. Milligrammes.	Loss in Weight. Milligrammes.	Loss per cent.	Ratio gold: silver.
—	9·9	—	0·0708	—	—	—
1	9·8	0·25	0·0685	0·0023	3	1 : 3·5
2	9 7	0 25	0·0662	—	—	1 : 3·5
3	9·8	0·25	0·0685	0	0	1 : 3·5
4	9·7	0·50	0 0662	0·0023	3	1 : 7
5	9·2	1·0	0·0571	0 0091	15	1 : 15

Average loss for each parting...... 8 per cent.
Maximum loss.......................28 "
Minimum loss. .... 0 "
Total loss on the combined
weights of the original
prills.........................0·0389 m. g. or 32 p. c.

Parting test G.—Gold, 0·0193 milligramme, parted from 2,500 times its weight of silver (0·05 gramme), yielded:
Gold...............0·0143 milligramme.
Loss on parting...0·0050 " or 25 p. c.

Parting test H.—Gold, 0·0126 milligramme, parted from 16,000 times its weight of silver (0·200 gramme), yielded after a second parting from a small excess of silver, necessitated by want of purity of the first prill:
Gold............ 0·0071 milligramme.
Loss on parting...0·0055 " or 43 p. c.

* Platinum also if present in the ore.

* I have convinced myself that gold-lead alloys containing minute quantities of gold are practically uniform in composition.

From these and other parting tests I conclude that the average loss in parting the one-thousandth of a grain of gold from silver is about 5 per cent.; in parting the one ten-thousandth of a grain, between 10 and 20 per cent.; that the loss increases with the proportion that the silver bears to the gold, and that this loss is partly mechanical and partly owing to the solvent action of the nitric acid upon the gold when in presence of silver or of products of the reduction of the nitric acid.

The variations that I have noted in the loss on parting I attribute either to the variable molecular conditions of the alloys (dependent possibly upon rates of cooling) or to variations in the heating during the action of the acid, giving rise to variable products of reduction of acid. Experiments are in progress to determine more accurately the cause of the solvent power of nitric acid upon minute quantities of gold.

Loss in Cupellation.—That gold suffers at most only an infinitesimal loss when cupellated with pure lead (free from silver) is satisfactorily proved by the accuracy with which the standard prill, the one-millionth of a grain, has been obtained by cupellation.

I will here briefly detail four experiments that show the gold suffers no appreciable loss during cupellation with antimony and copper.

Portions of gold, each 0·1 milligramme (0·00154 grain), were alloyed with 15 grammes (300 grains) of lead containing a trace of silver, and cupellated separately with—

(1) 0·5 gramme (8 grains) copper.
(2) 0·5 " (8 ") antimony.
(3) 2 " (30 ") copper.
(4) 0·5 " (8 ") antimony after scorification.

After parting, the residual gold was estimated to be in milligrammes respectively 0·098, 0·111, 0·097, and 0·100 in the four experiments.

Loss of Gold in Extraction from Siliceous Ores.—To enable me to experiment with ores containing proportions of gold equivalent to 2 dwts. or less per ton (0·0003 per cent.), I obtained from a rich gold ore siftings through a very fine sieve that gave fairly constant results on assay. This ore, in weighed quantity, was mixed with a large excess of sand and substances commonly occurring in quartz ores, that were themselves free from gold.

The mixtures thus prepared, representing poor gold ores of known content of gold, were assayed by the crucible method.*

visible head of yellow gold was obtained. It is thus possible, under favorable conditions, to recognize in a complex mixture even the millionth of a grain of gold.

This method of working under the microscope should be of value to geological science, by permitting of the search for gold in rocks neighboring gold deposits, and thus throw light upon the "origin of gold in veins and lodes."

Data Useful in Assaying.

Parts of ore.					Per ton. oz.	dwts.	grains.
100	yielding	0·00001	part of	gold=	0	0	1·5
"	"	0·0001	"	"	0	0	15·6
"	"	0·001	"	"	0	6	12
"	"	0·01	"	"	3	5	8
"	"	0·1	"	"	32	13	8
"	"	1·0	"	"	326	13	8

24 grains equal to 1 pennyweight. } troy.
20 pennyweights equal to 1 ounce. }
1 milligramme (mg.) equal to 0·0154 grain.
1 thousandth grain equal to 0·0648 milligramme.

Table of Cubes

Number.	Cube.	Number.	Cube.
1·0	1	10·0	1,000
1·5	3·3	10·5	1,157
2·0	8	11·0	1,331
2·5	15·6	11·5	1,521
3·0	27	12·0	1,728
3·5	42·9	12·5	1.953
4·0	64	13·0	2,197
4·5	91	13·5	2,460
5·0	125	14·0	2,744
5·5	166	14·5	3,049
6·0	216	15·0	3,375
6·5	275	15·5	3,724
7·0	343	16·0	4,096
7·5	422	16·5	4,492
8·0	512	17·0	4,913
8·5	614	17·5	5,359
9·0	729	18·0	5,832
9·5	857	18·5	6,332

For figures that are not given in the table, and that are higher than 8, approximate cubes may be obtained by taking proportionate differences.

Total weight of ore, grammes.	Weight of gold in milligrammes introduced according to average.	Average content of gold in grains per ton.	Constituents of ore other than gold.	Lead alloy from crucible, in gms.	Gold obtained in milligrammes.†	Gold obtained in grains per ton.	Apparent error in weight of gold.	Apparent error in grains per ton.	Remarks.
25	0·084	53	Silica.	17	0·103	63	+0·019	+10	
25	0·084	53	"	9	0·060	37	—0·024	—16	10 grammes only of litharge used.
60	0·084	22	"	20	0·085	23	+0·001	+1	
15	0·084	87	Silica, arsenic, copper.	10	0·103	106	+0·019	+19	2½ grammes arsenical copper precipitate.
15	9·084	87	Silica, zinc, sulphide.	11	0 093	97	+0·009	+10	Zinc blende, 2½.
20	0·084	65	"	23	0 093	73	+0·009	+8	Zinc blende, 5 grammes, calcined.
15	0·093	97	Silica, copper, antimony, sulphur.	20	0·094	98	+0·001	+1	2½ grammes ore containing chiefly copper, antimony, and sulphur.

The fine rich ore gave the following results on assay; in the first three tests the gold obtained was weighed, in the last six tests the gold was measured:

5	grammes ore	gave gold	4·1	milligms.	or 0·082 p. c.	
2	"	"	1·7	"	or 0·085 "	
1	"	"	0·8	"	or 0·080 "	
0·5	"	"	0·394	"	or 0·0788 "	
0 5	"	"	0·442	"	or 0·0884 "	
0·1	"	"	0·0885	"	} averaging 0·0877 p. c.	
0·1	"	"	0·0938	"		
0·1	"	"	0·0980	"		
0·05	"	"	0·0353	"		

I concluded that a fair average for the gold in 0·1 gramme would be 0·084 milligramme, with probable minimum and maximum amounts respectively of 0·0788 and 0·0980.

By means of 0·1 gramme, gold, according to the above average, to the amount of 0·084 milligramme was added to various materials, which were then assayed with the results given in table above.

In the second assay the gold was purposely separated under disadvantageous conditions, only 9 grammes of lead being produced in the fusion, but even here 70 per cent. of the total gold was isolated.

The above results indicate that one-tenth of a milligramme, or 1½ thousandths of a grain, of gold can be isolated from weights of siliceous ore ranging from 15 to 60 grammes, or from 200 to 1,000 grains in weight, even in the presence of copper, arsenic, antimony, zinc, and sulphur compounds.

Finding that a millionth of a grain of gold could be cupellated from lead without loss, I successfully attempted the recognition of the millionth of a grain of the metal, when in alloy, with a trace of silver. The parting was conducted with a small drop of nitric acid upon a microscope slide. The black sponge of gold that was left was distinctly visible under the microscope. Washing was performed by adding drops of water and carefully applying to the edge of the liquid small pieces of bibulous paper. By watching the sponge, this separation of the silver solution can be successfully performed without loss of gold.

After drying the slide it was again brought upon the stage of the microscope, and the gold picked up by means of a minute piece of pure lead fixed upon the point of a stout needle. By cupellation a distinct

* It would appear from my own observations, and from the experience of other assayers, that the method of fusion with litharge in a crucible gives results of greater accuracy than the method of scorification with lead. This is probably due to the difference in form of the two vessels, and no doubt accounts for the greater favor buyers show toward the latter method.

For cubes of numbers higher than those given, many can be obtained by taking the half of the figure and multiplying it by 8. Thus, the cube of 24 will be 8 times the cube of 12, or 1,728 × 8= 13,824. The cube of 19 would be 8 times the cube of 9·5, viz., 857 × 8 = 6,856.

The decimal points in the cubes have been omitted.

HYPNOTISM AS AN ANÆSTHETIC.

The *British Medical Journal* prints a long account of proceedings the other day at the rooms of Messrs. Carter Brothers & Turner, dental surgeons, Leeds, where upward of sixty of the leading medical men and dentists of the district witnessed a series of surgical and dental operations performed under hypnotic influence induced by Dr. Milne Bramwell, of Goole, Yorkshire, who is described as quite a master of the art of hypnotism as applied to medicine and surgery, and is shortly to publish a work of considerable importance on the subject.

The object of the meeting, says a local correspondent of our contemporary, was to show the power of hypnotism as applied to produce absolute anæsthesia in very painful and distressing operations. A woman, aged twenty-five, was hypnotized at a word by Dr. Bramwell. She was told she was to submit to three teeth being extracted, without pain, at the hands of Mr. Thomas Carter; and further, that she was to do anything that Mr. Carter asked her to do. This was perfectly successful. There was no expression of pain in the face, no cry, and when told to awake she said she had not the least pain in the gums, nor had she felt the operation. Dr. Bramwell then hypnotized her, and ordered her to leave the room and go upstairs to the waiting room. This she did as a complete somnambulist.

The next case was that of a servant girl, M. A. W., aged nineteen, on whom, under the hypnotic influence induced by Dr. Bramwell, Dr. Hewetson had a fortnight previously opened and scraped freely, without knowledge or pain, a large lachrymal abscess, extending into the cheek. Furthermore, the dressing had been daily performed and the cavity freely syringed under hypnotic anæsthesia, the "healing suggestions"

† The weights of gold in these test assays were estimated by comparison with 0·1 milligramme standards only. These standards were some of the earliest prepared, and were cupellated upon ordinary (somewhat rough) cupels. The estimate of diameters of 0·1 milligramme standards since prepared is such as to make these weights of gold about 12 per cent. less than those given. The same error applies to the last four tests in the preceding table. Reference is made, and this chiefly to impress the necessity for employing smooth cupels for obtaining prills.

being daily given to the patient, to which Dr. Bramwell, in a great measure, attributes the very rapid healing, which took place in ten days—a remarkably short space of time in a girl by no means in a good state of health. She was put to sleep by the following letter from Dr. Bramwell addressed to Mr. Turner:

"Burlington Crescent, Goole, Yorks.

"Dear Mr. Turner:—I send you a patient with inclosed order. When you give it her, she will fall asleep at once and obey your commands.

J. Milne Bramwell."

"Order. Go to sleep at once, by order of Dr. Bramwell, and obey Mr. Turner's commands.

J. Milne Bramwell."

This experiment answered perfectly. Sleep was induced at once by reading the note, and was so profound that at the end of a lengthy operation in which sixteen stumps were removed, she awoke smiling, and insisted that she had felt no pain, and, what was remarkable, there was no pain in her mouth. She was found after some time, when unobserved, reading the *Graphic*, in the waiting room, as if nothing had happened. During the whole time she did everything which Mr. Turner suggested, but it was observed that there was a diminished flow of saliva, and that the corneal reflexes were absent, the breathing more noisy than ordinarily, and the pulse slower.

Dr. Bramwell took occasion to explain that the next case, a boy aged eight, was a severe test, and would probably not succeed, partly because the patient was so young, and chiefly because he had not attempted to produce hypnotic anæsthesia earlier than two days before. He also explained that patients require training in this form of anæsthesia, the time of training or preparation varying with each individual. However, he was so far hypnotized that he allowed Mr. Mayo Robson to operate on the great toe, removing a bony growth and part of the first phalanx with no more than a few cries toward the close of the operation, and with the result that, when questioned afterward, he appeared to know very little of what had been done. It was necessary in this case for Dr. Bramwell to repeat the hypnotic suggestions. Dr. Bramwell remarked that he wished to show a case that was less likely to be perfectly successful than the others, so as to enable those present to see the difficult as well as the apparently easy, straightforward cases, "in fact," as he said, "to show his work in the rough."

The next case was a girl of fifteen, highly sensitive, requiring the removal of enlarged tonsils. At the request of Dr. Bramwell, Mr. Hewetson was enabled in a hypnotic state to extract each tonsil with ease, the girl, by the suggestion of the hypnotizer, obeying every request of the operator, though in a state of perfect anæsthesia. In the same way Mr. Hewetson removed a cyst, of the size of a horse bean, from the side of the nose of a young woman who was perfectly anæsthetized and breathing deeply, and who, on coming round by order, protested that "the operation had not been commenced."

Mr. Turner then extracted two teeth from a man with equal success; after which Dr. Bramwell explained how his patient had been completely cured of drunkenness by hypnotic suggestion. To prove this to those present, and to show the interesting psychological results, the man was hypnotized, and in that state he was shown a glass of water; he was told by Dr. Bramwell it was "bad beer." He was then told to awake, and the glass of water offered him by Dr. Bramwell; he put it to his lips, and at once spat out the "offensive liquid." Other interesting phenomena were illustrated and explained by means of this patient, who was a hale, strong working man.

Mr. T. S. Carter next extracted a very difficult impacted stump from a railway navvy, as successfully as the previous case. Dr. Bramwell described how this man had been completely cured of very obstinate facial neuralgia by hypnotism, which had been produced by working in a wet cutting. On the third day of hypnotism the neuralgia had entirely disappeared (now some weeks ago), and had not returned. The man had obtained refreshing hypnotic sleep at nights, being put to sleep by his daughter through a note from Dr. Bramwell, or by telegram, both methods succeeding perfectly.

At the conclusion of this most interesting and successful series of hypnotic experiments a vote of thanks to Dr. Bramwell for his kindness in giving the demonstration was proposed by Mr. Scattergood, Dean of the Yorkshire College, and seconded by Mr. Pridgin Teale, who remarked that the experiments were deeply interesting, and had been marvelously successful, and said: "I feel sure that the time has now come when we shall have to recognize hypnotism as a necessary part of our study." The vote was carried by acclamation.

ATROPINE AS AN ANTAGONIST TO CHLOROFORM.

From the fact that atropine paralyzes the inhibitory nerves of the heart and acts as a stimulant of the respiratory center, Albertoni many years ago recommended the use of atropine in accidents occurring during the use of chloroform as an anæsthetic, or in conditions where the heart was arrested through reflex stimulation of the vagus and paralysis of respiration.

He based this advice on his experiments on dogs, which, while, as a rule, highly susceptible to chloroform, were yet able to sustain the administration of immense amounts of chloroform, if atropine was injected subcutaneously before the production of anæsthesia.

Caselli and Secondi repeated these experiments in numerous cases of accidents occurring with the use of chloroform, and they now state that they never administer chloroform without having previously given a hypodermic injection of atropine.

In the *Centralblatt fur Klinische Medicin*, No. 45, 1889, there is an account of a number of experiments made by Dr. L. Vincini in this connection, his results serving to confirm Albertoni's statements, and success only failing to appear when such an immense amount of chloroform was given that there was coagulation of the heart tissue produced. He likewise recommends in every case of chloroform anæsthesia, as a prophylaxis, the subcutaneous injection of $\frac{1}{25}$ of a grain of atropine. Half the amount may be given to children, while double the dose may be given in an emergency from the use of chloroform.—*Therapeutic Gazette.*

ADOUA.

THE newspapers tell us that since the 26th of January of the present year the Italian flag has been floating at Adoua; we therefore trust that we may interest our readers by devoting a few lines to the capital of Tigre.

Adoua is located astride a hill at an altitude of 6,300 feet above the level of the sea. It is surrounded by high, bare mountains. The city consists of cottages covered with thatch and separated from each other by thorn hedges. Some of these (those of the aborigines of distinction) are pretty well constructed, and the walls are made of pebbles cemented with clay and straw. The others (those of the people) are much ruder, the sides consisting of branches of trees inserted in the ground and interlaced so as to hold the pebbles that are to form the wall. Some of these cottages have a basement which is reached through an external stairway constructed of pebbles.

This basement, during the rainy season, would prove very convenient, were it not that the insects that swarm in it and the absence of light rendered an abode therein impossible.

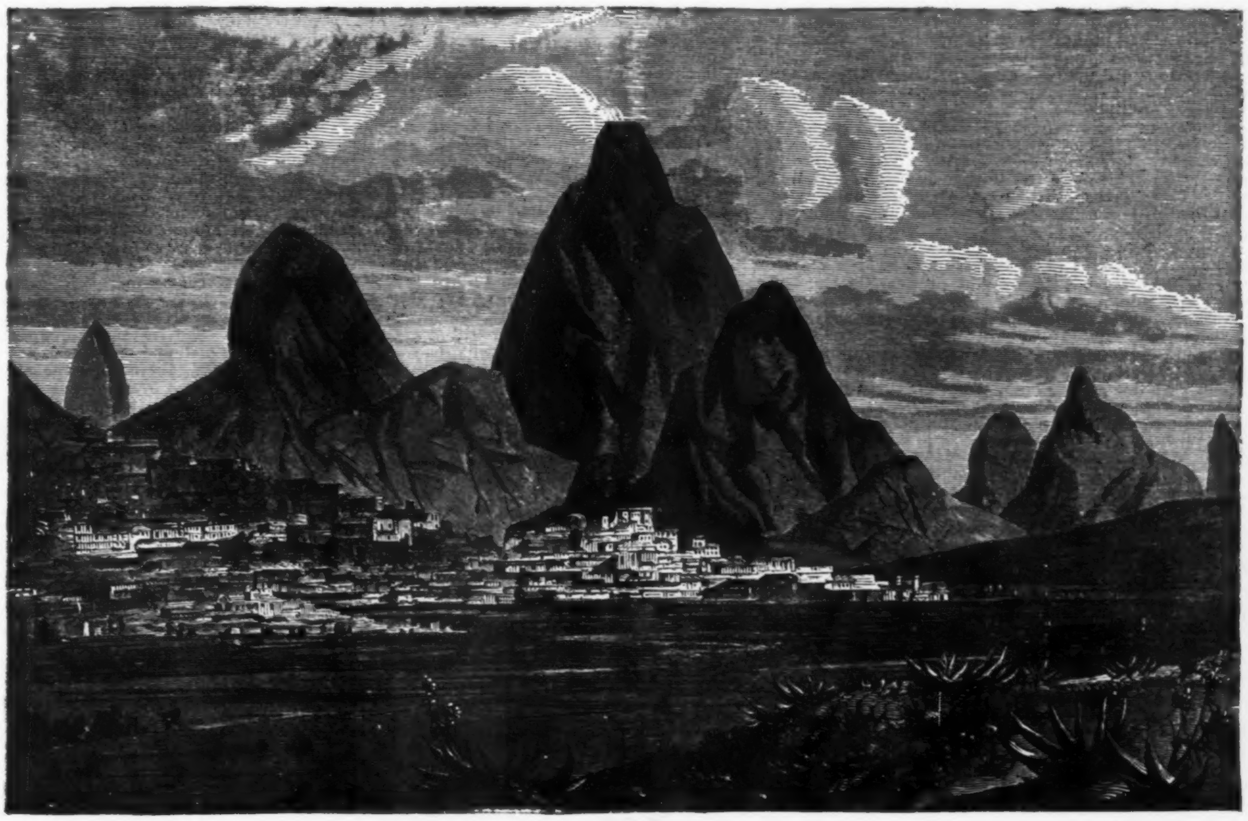
The residences of the king and governor, along with the churches and the cathedral, occupy the best positions.

The capital of Tigre contains no shops, so that the natives cannot provide themselves with provisions of prime necessity except from the merchants who frequent the markets of Adoua. One of these markets attracts to the city every week the merchants of the distant regions of Abyssinia.

Adoua is divided up into narrow and tortuous streets, which, with the yards of the cottages, are pretty dirty. It is a very common thing to meet therein, at every step, piles of manure or the heads of animals newly severed and left to atmospheric influences. Now, when the rainy season comes on, alternated by days in which the sun is broiling hot, all these foci of putrefaction vitiate the air with miasma more than sufficient to cause terrible epidemics. Such is the cause of the very perceptible decrease in the population of Adoua, which amounted a few years ago to 6,000 inhabitants, and which now amounts to but 2,000.

Water is pretty scarce at Adoua, and, moreover, it is of bad quality. The natives use for their own requirements the water of the Assem, a tortuous river that flows at the foot of the city. Like almost all the rivers of the region, the Assem is merely a brook in ordinary weather, and which changes to a genuine torrent in the rainy season.

At twelve miles from Adoua, to the west, is situated Axum, a very important religious center, where are found a number of magnificent obelisks and ancient monuments.—*La Science en Famille.*



ADOUA.

CULTURE OF STRAWBERRIES AND OTHER FRUITS.

AT a recent farmers' meeting at the Ploughman's Hall, Boston, Mass., Mr. F. J. Kinney, of Worcester, spoke as follows:

Strawberries are first in season, so we will consider them first in our talk on this question. Any land dry enough to grow any farm crop will grow good strawberries of some varieties.

There have been some that would do fairly well on any well drained soil, such as Wilson, Charles Downing and Crescent. Others will only thrive on a heavy soil. Jucunda, Sharpless, Bidwell or Kinney's Eclipse, Jewell, and others belong to that class. Some seem to be partial to particular localities. The old Hovey and Wilder and newer Belmont seem partial to the salt air, and do very poorly with me.

I'm inclined to the belief that the Miner's Prolific—not a new berry, but one that has been set aside by many without a proper trial—is one of the best that I have to-day, for my purpose. Our market is near, but Miner's will stand as much carriage as Chas. Downing, is a more vigorous grower, more prolific bearer, with a nearly perfect foliage. It is not a good berry to grow with the Downing, for the Miner is a red berry and the Downing needs to be picked while many are quite light colored.

Every year brings many new seedlings, and that is well; for we in our greed for gain soon destroy the vitality of our plants. It is very unwise to ever set a young plant of a running variety from a bearing bed. Nature has decreed that, to produce, the seed shall be the aim and end of a plant, and the strawberry is the seed.

WHAT KIND OF SOIL?

That will depend upon what variety you want to grow, and after hearing my experience you will none of you fertilize with white grubs, and I would say in this connection that earth or fish worms are but little better in my opinion. It pays well to prepare your ground thoroughly for strawberries, and get the weeds well killed in advance of setting the plants, and there is no crop that responds to irrigation as readily.

Fertilizers are an important item. The strawberry is a potash plant; hence, they always do well on land where there is plenty of decomposed sod.

I have grown excellent crops on land where I used one-half ton of fine ground bone and 500 lb. muriate potash, spread on the furrow and harrowed in. Am speaking of old pasture land too poor to grow any more grass, or for worms to live in, plowed in the fall and planted one year to corn or potatoes, then plowed again in the fall and the strawberry plants put in the next spring.

There are many who have grown large crops of nice strawberries on manured land, either horse or cattle manure, but as a rule special or commercial fertilizers grow less tops and more and better fruit.

SETTING THE PLANTS.

There are as many ways almost as growers. There are a few things one will have to learn for himself in this as well as all other kinds of business. The amateur who only wants a small patch should use a good deal of care, but if the plants are good and freshly dug, and they are set early enough in the season—in this climate every plant ought to be set in April—they will mostly grow. On our hard land we use a heavy, highly polished steel dibble, fastened to a strong wooden handle, with a cross-stick at top, and a heavy foot pin near the ground, so a man can press it into the soil with hands or foot. It is about three inches wide, and two men and a boy can set four or five thousand plants a day easily and well. The man who sets the plants has a piece of the upper end of a fork handle, a foot long, with the lower end sharpened, with a blunt point to firm the dirt around the roots.

One to set strawberry plants successfully wants to know how they grow naturally, and not plant them too deep in the soil.

I have seen soils where an ordinary spade was one of the best things to make the hole with. It gives a long place to spread the roots.

THE DISTANCE APART.

We grow on the matted row system, and set the plants sixteen inches to twenty-four inches apart in the row, and the rows four feet apart, running a cultivator close up to sixteen inches, between the rows for plants, and letting the plants take the rest of the ground. We think it pays to layer the first plants that run out with some slow-growing varieties. All the young plants are layered. We always cut off all blossoms from new set beds and always take our plants from new beds, from beds that never have grown berries.

MARKETING THE FRUIT.

Many men who work hard and intelligently all through the various and complicated matters we have discussed fail in the end because of a little carelessness or want of knowledge. I am talking now about the person who grows for market; for any person, even if they never saw a strawberry before, would know how to eat them.

First, then, the looks of the package has as much to do with its sale as anything, for a remunerative price. Having clean crates and boxes is the first step, and assorting and handling carefully, the next. I never allow any one to take hold of a good strawberry with their fingers. The stem was made to handle them by.

Now, ladies and gentlemen, don't be afraid to go in and raise thousands of bushels more of nice strawberries any year. Study to grow and handle them as cheaply as you can, and get as many as one hundred bushels to the acre, and you can grow more and you never will regret it, for they are the queen of Nature's productions.

Next on our list come the raspberries—beginning to ripen before the strawberries are gone, and lasting until the blackberries come.

They require about the same conditions of soil as the strawberry, will always be grateful for a plentiful supply of pure water, although they don't enjoy having their feet wet all the time. Mulching is a partial protection for them, and the best kind of mulch for a wide-awake grower is an inch or so of dry, loose earth on top of the ground, produced by running the cultivator often in dry weather. If a person is a little lazy, they will find it will pay to cover the ground between the rows with hay or leaves to the depth of two or three inches. To be effectual, this should be done early.

FERTILIZERS FOR RASPBERRIES.

They are gross feeders, and one need not be afraid of giving them too much. They should make their growth of new wood for the next season's fruitings as early in the season as possible, so it may get well ripened before the cold weather; hence you should either have decomposed stable or horse manure or special chemical manure, and it should be in the soil early in the spring. We all need to stick a pin just here. The plants are in the soil and wide awake to catch the first warm rays of the spring sun, while the soil is filled with the winter's accumulation of moisture that holds Nature's store of accumulated fertilizers; now, we want to be on hand with our mites to go along with Nature's bountiful supply, while the plants are looking for it, remembering all the time that the roots and rootlets require different substances for growing canes and foliage than they will later on to grow fruit and ripen the wood.

VARIETIES TO GROW.

That depends again upon who is doing the business. The amateur may, and should, grow many varieties, and if he or she has an income to fall back on, they should try all the new varieties, because it is absolutely necessary that we encourage the production of new varieties; and last, though not least, by any manner of means, they will find the expectation of having something a great deal better than they have ever seen before, a great incitement to watchfulness and care, and a healthful stimulus to their circulation.

The cultivators for the market want but few varieties, and they want what will sell best in the market, what will be the most easily and cheaply cultivated on their soil, and will be the most attractive when it reaches the consumer. I am very sorry to feel obliged to emphasize that word; wish I could conscientiously use one indicating quality, but facts are stubborn things, and we must deal with them as we find them.

We find the Cuthbert and Brandywine the best red varieties; in fact, all that can afford to, should grow them for the market.

The Marlboro has all the elements in its fruit for a first class market berry, but the foliage is very treacherous with us.

The old Hudson River Antwerp should be in the collection of every amateur, as also Brinkles Orange, for they possess fine flavor.

For black raspberries the Tyler or Souhegan for early and Gregg for late seem the best. They are not hardy with me; the Nemaha, originated by Governor Furnas, of Nebraska, is said to be hardy.

The Brandywine is the only raspberry I have ever fruited that never has winter-killed, and it grows better each year.

Blackberries come next. We never have found them as profitable to grow as strawberries or raspberries. Are easy to grow, and nice to have in the family, and will pay better than any ordinary farm crop, but they come into market at a season of the year when there is a great variety of fruit, peaches in particular, and like strawberries, every person eats peaches—in their season.

Soil and cultivation is like that of the raspberries. Most people set both too near together. The rows eight feet apart, and the hills three feet apart, is about the best distance, and only to leave three or four canes in a hill.

We have grown our berries full length, and used wire trellises to hold them up—twisting the raspberry canes around the wires, and tying the blackberries to them; but we may grow both on the hedge plan, cutting them down to three feet high, and pinching the laterals back to a foot in length, after this, Snyder and Wachusett are the standard blackberries.

The Snyder seems to be as near an "Ironclad" as possible, and is very productive, not very good, but always sells. The Wachusett is good and handsome, and on a good, strong soil is a profitable berry to grow.

The Early Harvest is a prime berry, and productive enough to satisfy most people, has done well with us two years, not quite long enough to test it thoroughly, but shall increase the size of our plantation this spring.

Some of the dewberries are very desirable for the amateur, the Leucretia being the best we have tried; and they may prove productive enough for a market berry. Are very large and nice.

It has always been a wonder to me that some person did not grow blueberries. I have always intended to try them, but for some reason never have. There is a man in Worcester City who has a few bushes in his garden, and he has occasionally exhibited the fruit at our horticultural exhibitions, and they attracted much attention.

Were very large and fine flavored. I have seen bunches of bushes of wild low-bush blueberries set growing on a few feet of land, that would produce many quarts of nice fruit.

I suppose I must say something about grapes; but the time has come when it almost seems as though we should have to give up trying to grow them for money in New England.

If a person has a very favorable location, and plenty of patience and time, they can grow and ripen Moore's Early, Worden, and perhaps the Concord in the open vineyard nearly every season; and there are a few of Roger's numbers, No. 3, Massasoit; No. 9, Lindley; No. 15, Agawam; No. 19, Merrimac; and No. 4, Wilder. There are many other varieties that have been introduced, good, bad, and indifferent, that will generally pay the amateur for lots of thought and trouble.

One of the oldest good grapes is nearly absolute in my locality, the Diana. It is a winter grape. At one time there came a very hard early frost, before the grapes were colored, and when I went into my vineyard in the morning, where there were over forty varieties, all but the Dianas were so hard frozen that they rattled like stones; they seemed so free from frost that we gathered an orange basket full and put them in the cellar, where they ripened and were good.

SOIL AND CULTIVATION.

High, dry land, sloping southwest, where the last rays of the sun lie on the ground, seems best in this climate, and the rows should be far enough apart so the sun can warm the land.

Currants are a very desirable fruit to grow, and are freer from disease than any.

They will do well on a greater range of soil than any other of the small fruits but strawberries. When once well set out they will last, with good care, for many years, and yield good paying crops. They like lots of fertilizing, but are not as particular as some others about their feed.

They should be set far enough apart each way so they can be worked with a horse, and in straight rows, every way.

Five or six feet apart each way is none too far. The red varieties are supposed to be the best by most people, but my experience goes to prove that one-third at least of white ones give the best satisfaction for jelly, and most people like the white ones best on the table.

There are a few wise societies in Europe and in Massachusetts that rule out the cherry, and say there is no such variety; they are versaillaise, but all they may say don't make it so. The cherry currant is the best red currant I am acquainted with, and a very distinct variety, the versaillaise coming next, and the white grape is the best white variety. There are a few new ones, Fay's Prolific, etc., that for the present belong to the amateur.

There is a limited demand for black currants, but not enough to pay for growing them, which is also true of gooseberries.

They are a very desirable fruit for those who know how to use them, and can be grown if any one has the time to attend to their many whims; all the varieties worth growing are more or less foreign in their make up, and withal rather aristocratic. The Downing is the best old one, and the Industry the best new one.

An essay on this subject would not be complete without devoting some space to insect and other enemies of our pets.

Thirty years ago they were few and far between. Now, their name is legion, and the air and the earth is full of them. Then the tiller of the soil planted his strawberry bed, and when night came, he could retire to rest and feel sure they would grow and bear fruit, if he knew there were no white grubs or earthworms in the soil. Not so now. The flea beetle has come, and several kinds of fungi, so that instead of getting the best paying crops the third and fourth years from his beds, he must renew them every year, and seek new and distant fields at that.

The red raspberry has its cicada to lay her eggs in the canes in the soft state, to remain till spring, when they will hatch and eat out, causing the cane to break off and several species of rust to sap the life from their leaves.

The blackberry has also fungi, and the rusts, red and gray, and also a leaf hopper.

The only remedy I know of for the fungi and rusts is to destroy by burning every bush, root and branch that it appears on. The leaf hoppers have not appeared in large numbers enough yet to do much damage. It seems now that by using minerals more and stable manure less, we were preventing the spread of the rust, and growing better berries.

The currant is the freest from disease of any of the small fruits. The currant worms are ominipresent, and they get there just the right time always. But two applications of white hellebore will destroy them in the spring, and usually one application is enough in the fall. A person has to be wide awake and find them soon after they hatch, for they are voracious fellows, and it only takes a day or two to destroy a large plantation. We use the dry hellebore, putting it on with a sifter such as I use to put Paris green on potatoes, or with our spraying nozzle on a force pump. Stir two or three tablespoonfuls into a pail of water. The dry powder should be mixed into a paste with a little water first and then stirred into the water in the pail. Some sprinkle the water on with a small corn broom, or wisp of straw. If you use the dry hellebore, put it on when the leaves are wet.

The same kinds of worms destroy the foliage of the gooseberry if they get a good chance, and they can be killed on them in the same way.

The mildew that destroys the fruit of the gooseberry is not so easily handled yet, but we hope the Bordeaux mixture will prove a successful weapon in combating it.

The grape vine is sorely pressed—its enemies are legion. The rosebug is the first to attack it, and when they are plenty, if there are many vines, there will be work for many fingers, many days. The sure way is to pick them off in the morning, while inactive. We put half an inch deep of kerosene oil in a pint cup, and pick the bugs into it. You can pick the cup solid full, and empty them out, putting in more oil, etc. After they are once fairly in the cups, they are no longer dangerous.

Some say to sprinkle the vines when wet with dry lime will keep them off, and the various fungi. It is worth trying. The Bordeaux mixture is the fungi remedy sent out by government as a sure preventive of the depredations of the fungi, that attack grape vines, causing the downy mildew and the black rot, and the chief of the section of vegetable pathology, Mr. B. T. Galloway, has no doubt but it will destroy all other fungi that attack the fruit or foliage of our various fruit and ornamental trees, as also the potato fungi.

When the vines are dormant, sixteen pounds of sulphate of copper and thirty pounds of lime to twenty-two gallons of water are recommended, but after the leaves and blossoms have appeared, only six pounds of sulphate of copper and four pounds of lime to twenty-two gallons of water are to be used.

There are machines made on purpose to apply the mixture with; the best is the Eureka sprayer, fitted with the vermorel nozzles.

The sulphate of copper is to be dissolved in twenty-two gallons of water, and the lime must be quick, or unslaked, and be slaked in six gallons of water. When the lime has cooled, mix with the copper solution thoroughly.—*Mass. Ploughman.*

THE HEMLOCK SPRUCE.

With the exception of the white pine, the hemlock spruce must be regarded as the most valuable of all the trees of the United States east of the Mississippi River, so far as abundance of timber products up to the present time is concerned.

The wood, for many purposes, especially in the unexposed parts of structures, has no superior, if, indeed, it has any equal. Its capacity for holding nails is greater than that of white pine, while its durability is equally great in corresponding exposures. With these qualities in its favor, the hemlock must be regarded as worthy of careful consideration with reference to its bearing upon the important forestal problems of the nation. In the brief paper I have prepared for the present occasion, I have drawn my matter largely from a report upon the hemlock, prepared by me for the Forestry Division of the Department of Agriculture, based upon a somewhat extended study of its biology, history, and economy.

The wide range of the hemlock, covering, in its natural distribution, more than one-half million square miles, extending through thirty degrees of longitude and thirteen of latitude, would of itself suggest its adaptation to forestry. The impression received from its distribution is further strengthened by the fact that the tree grows naturally in a considerable diversity of soil, climate, and situation. Few trees of our native forest are more marked in this respect, and, somewhere within its range, it is found as an associate of nearly every species of the arboreal flora of Eastern North America north of Alabama. If, however, we examine the question from the standpoint of actual experience in the cultivation of the hemlock, the matter appears far less encouraging.

1. The demands which the hemlock makes in regard to soil and climate are of so general a nature that no obstacle to its cultivation can arise from this consideration, although, like other plants, it manifests a certain preference for particular situations. Throughout the area covered by its natural distribution there are millions of acres adapted to the highest development of the hemlock which are unfit for any other than forestal purposes. No requirements exist, therefore, in regard to soil and climate, which are not amply supplied.

2. The tendency of the hemlock to renew itself naturally on areas which have been largely or completely deforested is less marked than that of most other tree species. Still, the tendency to natural renewal is by no means wanting. I have seen a large pasture adjacent to a piece of hemlock woods well stocked with a growth of young hemlocks. They bore evidence of having been disturbed by cattle, but there were abundant indications that if left to themselves they would completely reforest the area on which they were growing. Other similar instances have been mentioned by correspondents in numerous locations. The hemlock is an abundant bearer when once it has reached the fruiting age, although the seed crops are biennial. The seeds are shed at different periods, extending from autumn until spring. Fertile seeds have been found in the cones as late as the last of April. The seeds, if favorably placed, germinate freely, the specially favoring conditions being a moderate amount of shade and moisture. The latitude, in this respect, is not great, as any considerable excess of moisture causes the young plants to damp off, while from any great lack of it they wither and perish. While the young plants must be regarded as exceedingly delicate, they are, nevertheless, capable of enduring a considerable range of climatic and other conditions. There seems to be no inherent reason in the nature and constitution of the hemlock to operate against its natural renewal on areas from which it has been removed, provided the conditions are favorable to that end. The essential conditions are twofold: First, the rigid exclusion of all domestic animals; second, obviously and chiefly, the prevention of forest fires. While these conditions apply to all tree species in common with the hemlock, they are relatively of greater importance in regard to the latter on account of its constitutional delicacy. A third condition would be the removal of a certain proportion of the seedlings of other species which are endowed with a greater degree of vigor.

3. In regard to the cultivation of hemlock in nursery rows for subsequent transplanting, practical experience shows its want of adaptation to this purpose. In its seedling state it is probable that no other tree species is of so slow growth; at the end of its first year a seedling is rarely more than an inch in height; and at the end of its third or fourth year it has increased to scarcely more than three inches or four inches. This low growth is characteristic of the hemlock during many subsequent years, although at a later period the relative rapidity of growth is somewhat increased. While these facts materially lessen the adaptability of the hemlock to forestry, they do not prevent the employment of the hemlock in the renewal of forests in the method previously considered. Moreover, it should be stated that while the rate of growth here indicated is based upon my own experience and observation, and is confirmed by many correspondents who have had great experience in the cultivation of the hemlock, there are a few correspondents who consider it to be, in specially favored situations, as rapid a grower as most other conifers.

4. A few facts concerning the consumption of the products of the hemlock may be here noted. What are regarded as trustworthy estimates place the amount of bark used for tanning purposes in 1887 at 1,200,000 tons, which at 32s. per ton would represent a value of £1,920,000. Estimating the amount of manufactured lumber at 1,500 feet per ton of bark would give 1,800,000,000 feet as the total amount, representing a value, at £2 8s. per 1,000 feet, of £4,320,000. While a considerable portion of the peeled timber is wasted, and should be deducted from the above estimates, it is believed this amount is made good by the use of unpeeled timber for railway ties, fuel and various other purposes. It may, therefore, be estimated that the full value of the products of the hemlock is, in round numbers, £6,000,000 per annum. The length of time during which our remaining hemlock forests will continue with this annual drain upon them is, of course, uncertain; but the most careful and conservative observers consider that the present supply could not be maintained for a period exceeding twenty or twenty-five years. It becomes, therefore, a question of great practical importance as to the way in which the existing demands upon the hemlock shall be hereafter supplied. These supplies can, of course, be afforded in only two ways: First, by the substitution of corresponding products from other trees or other sources; second, by the renewal of the hemlock forests.

The general conclusions which have been arrived at as the result of a somewhat careful investigation of the present subject may be briefly summed up as follows: The hemlock has been from the earliest settlement of the country a tree of vast economic importance to the people of the Eastern and Northern States; that in this respect it has been second to none of our native forest trees, with a possible exception of the white pine; that the tree has been exhausted from vast areas where it formerly existed in great abundance; that at the present rate of consumption the entire supply will be practically exhausted in from twenty to thirty years; that nothing has been anywhere done toward reforesting the areas from which it has been removed; and that its nature and constitution afford only a moderate promise of its adaptation to economic forestal purposes.

Finally, it may be stated that the most prominent result of the investigation to which I have referred has been to give great emphasis to the fact, not as yet sufficiently recognized, that the country ought to give prompt and energetic attention to the whole subject of forestry, that no successful forestry management is possible in the absence of adequate knowledge of the subject, and that this knowledge is attainable only through intelligent experiment, experience, and study.—*Read before the American Forestry Association by Professor A. N. Prentiss.*

THE COLOR OF FISHES.

By G. Brown Goode.

The skin of a fish, upon the structure of which its color depends, consists of two layers—the outer, or epidermis, delicate, transparent, and not supplied with blood vessels; the inner, the corium or dermis, laminated and elastic, varying in thickness in different species and in different parts of the body, and permeated by blood vessels and nerves. Between the skin and the underlying muscles is a layer of loose connective tissue, often loaded with fat, especially in the mackerels and salmonoids and in the herring tribe. In the menhaden this layer is thick, hard, and blubber-like.

The scales are modifications of the dermis, and are ordinarily thin, transparent, horny plates, with rounded

quadrangular outlines, which are partially embedded in folds or pockets in the dermis, and covered by the epidermis, through which, however, their tips protrude. The scales are usually imbricated, overlapping each other like the shingles on a roof, but are sometimes separated and embedded, and partly hidden in the skin, as in the eel.

In fishes which live near the bottom and among the rocks, such as the sea bass, red snapper, sheephead, and perch, the scales are usually thick, hard, closely imbricated, and deeply set in their sheaths, forming an impermeable coat of mail.

In fishes which live in the mud, such as the tautog, the burbot, and the carp, the scales are usually covered by thick layers of epidermis and mucus.

In fishes which swim free and far from shore, such as the herrings and the lake white fishes, the scales are attached merely by a small area of their rims, and, being but slightly covered with epidermis, are easily rubbed off. Scales thus removed are in many fishes easily renewed.

The smooth polished surface of the closely set scales offers little resistance to the motion of the fish as it glides swiftly through the water.

The exposed surface of the ordinary fish scale is usually covered with a thin silvery coating, which derives its brilliant metallic luster from the presence of numerous crystals of a combination of guanin and lime. This coating may readily be loosened and rubbed off, and in one European fish, the bleak or ablette, a member of the carp family, the crystals are sufficiently abundant to become the source of the metallic pigment known in the arts as *essence d'Orient*, or argentine, which is used to impart a nacreous luster to the glass globules sold under the name of "Roman pearls." When the silvery coating is absent, scales are lusterless and transparent, as in the smelt, the abdominal cavity of which, however, has a brilliant silvery lining composed of the same substance.

The colors of fishes are very varied, and often exceedingly brilliant and beautiful. "Aucune classe d'animaux n'a été aussi favorisée à cet égard," says Lacépède; "aucune n'a reçu une parure plus élégante, plus variée, plus riche; et que ceux qui ont vu, par exemple, des zées, des chétodons, des spares, nager pres de la surface; d'une eau tranquille et réfléchir, les rayons d'un soleil brillant, disent, si jamais l'éclat des plumes du pœon et du colibri, la vivacité du diamant, la splendeur de l'or, le reflet des pierres precieux, ont été mélés à plus de feu, et ont renvoyé a l'œil de l'observateur des images plus parfaites de cet arc merveilleusement colorie dont l'astre du jour fait souvent le plus bel ornament des cieux."

The colors are often due to a simple arrangement of pigment cells, placed at different depths in the skin; but those changeable and brilliant hues which constitute the greatest beauty of fishes are dependent, as Pouchet and others have shown, upon two very dissimilar causes.

One of these, which may be well observed in the scales of the herring, shad, or mackerel, is a true iridescence, similar to that seen in the pearl or in antique glass, and due to the refraction of the rays of light as they glance off the surfaces of thin plates or ridges in the scales. This is called "lamellar coloring." There are certain bodies called "iridocytes" (rainbow plates) embedded in the epidermis which have an important function, it is said, in this iridescent play of colors.

The coloration is, however, chiefly dependent on the arrangement of the pigment cells, or chromatophores, which lie in the lower strata of the epidermis. These are black, yellow, and red; the latter, according to Pouchet, being capable of dimorphic changes into blue and green. The combinations of the various hued chromatophores with the metallic crystals of silver, the white of the bony scale plates showing through the epidermis, and the iridocytes already referred to, produce the coloration of every kind of fish.

An embryonic fish is colorless; but the pigment cells of black, yellow, and red soon begin to appear, as is shown in Alexander Agassiz's beautiful plates of the early stages of flounders and other species, published in the "Bulletin of the Museum of Comparative Zoology."

When the black pigment predominates, the color is somber, as in the adult tautog, *Tautoga onitis*. A slight admixture of yellow gives the bronze-like hue of the eel, and a little more of the same results in the brighter green of the black bass, the bluefish, and the cunner. In all of these there is a sprinkling also of red, giving the warmer brownish greens so often seen in these species. Red pigments intermixed with black give the dingy browns of the carp, the sculpins, and some of the catfishes.

When the yellow and red outnumber the black cells, there result the tawny colors of the sand dabs, the sunfishes, the cusks, and the ling, and of some varieties of the cod.

Red chromatophores alone cause the brilliant scarlet of the red snapper and the rosefish, and, when these are interspersed with black, the deeper colors of the mangrove snapper and the ruddy variety of the searaven. When the chromatophores begin to segregate into separate groups according to color, the result is the formation of bands, stripes, spots, and shadings infinite in their possibilities of mutation and combination, and quite beyond the power of words to describe.

The entire absence of chromatophores results in albinism. I have already called attention to the curious albino haddocks occasionally taken on our coast. Sometimes these are of a light golden color, and are in what Gunther calls a state of "incipient albinism," the dark pigments having changed into yellow. This has been observed also in flounders, carps, and eels, and in the gold fish, which in its native haunts in China is a dull green.

The golden orfe and the golden ide have become permanent in a state of domestication.

The silver fish, a form of gold fish, is an example of still more complete albinism; and a combination of the two conditions is very common in the breeding ponds of the United States Fish Commission.

The blind fish of Mammoth Cave, *Amblyopsis spelæus*, is an illustration of permanent adaptive albinism; and in the abysses of the sea, where the light is very scanty, many fishes appear to remain permanently in this condition.

Adaptive coloration seems to be possible in quite another way, through the secretion of pigment cells, which permanently change the color of the fish to make it harmonize with that of the bottom upon which it lives.

On certain ledges along the New England coast the rocks are covered with dense growths of scarlet and crimson seaweeds. The codfish, the cunner, the searaven, the rock eel, and the wrymouth, which inhabit these brilliant groves, are all colored to match their surroundings; the cod, which is naturally lightest in color, being most brilliant in its scarlet hues, while the others, whose skins have a larger original supply of black, have deeper tints of dark red and ruddy brown. These changes must be due to the secretion of a special supply of red chromatophores.

It has occurred to me that the material for the pigmentary secretion is probably derived indirectly from the algæ, for, though the species referred to do not feed upon these plants, they devour in immense quantities the invertebrate animals inhabiting the same region, many of which are likewise deeply tinged with red. Possibly the blacks and greens which prevail among the inhabitants of other colored bottoms are likewise dependent upon coloring matter which is absorbed with the food.

Gunther believes that the pink color in the flesh of the salmon is due to the absorption of the coloring matter of the crustaceans they feed upon.

Spoonbills and flamingoes lose the brilliant pink tints of their feathers after long confinement in menageries, and it is customary for European zoological gardens to send them to the garden at Rotterdam to be recolored. It is not known how this is done, but it is supposed that they are fed upon some red-hued crustacean there obtainable.

The brilliant coloration of many kinds of fishes during the breeding season may possibly have a relation to sexual selection; indeed, this can scarcely be doubted by any one who has observed the peacocking moments of male fishes. It has also a physiological significance which it is not difficult to comprehend. The increased brilliancy is usually most manifest in those parts of the body which lie close to the reproductive organs, in the belly, which is often flushed and vivid in color, in the ventral fins, and in less degree in the sides of the body and the posterior and lower parts of the head.

The entire vascular system is in a condition of extreme activity at this time, as is evident from the manner in which outgrowths of the head and teguments are so rapidly developed. Every pigment cell is receiving an unusual supply of blood, and its more abundant nutrition is, in part at least, the cause of its brilliancy.

If an abundant supply of blood results in an increase in brilliancy, its withdrawal from the teguments, on the other hand, causes an immediate decrease. I have often watched the large brightly striped "groupers," *Epinephelus striatus*, confined in the crystal fish pools in Bermuda. When one of these had swallowed a large morsel of food, its color became almost instantly lighter and duller. This was evidently the result of the rush of blood to the stomach, to take part in the work of digestion: in like manner a man's face often becomes paler after he has eaten a hearty dinner.

The dullness and pallor in the color of fishes after death are due to the absence of living blood from the chromatophores. If, however, a fish not long dead is placed in the sun, its color will soon become almost as deep and bright as in life. In a few seconds it fades again, and cannot again be brightened.

This phenomenon leads to the consideration of another peculiarity in the arrangement of the pigment cells, which renders rapid changes in hue possible in certain species. In these the pigments are associated with oily matter, and are arranged *areolæ*, which favor their approach toward or retreat from the surface of the skin. They may sometimes show as small, irregular spots upon the skin, and soon after become conspicuous star-shaped markings with far-reaching arms. Such changes may be effected by stimulation of various kinds, and even by the reflex action of the nerves under the influence of impressions of color received by the eye of the fish.

Every angler knows that trout inhabiting stagnant pools or dark bottoms are deep colored, while those from deep, sunny waters are brighter. The same is true of many other fishes. I have often seen the common flat-fish change its color to that of the gravel and sand in which it was trying to hide, the hue varying as rapidly as that of the landscape when the sunlight is suddenly cut off by a passing cloud.

These changes of color are directly connected with the impressions of color received by the eye, and brought about by the reflex action of the nervous system. In no other way can changes such as those already referred to in flounders be accounted for. I have seen the tropical squid in Bermuda change color rapidly, and at will, while being pursued. This was evidently through the influence of emotion or fear, since it can hardly be supposed that there was definite purpose in the act; which, however, seemed at first sight to be intended to baffle its pursuers.

Pouchet experimented with young turbots, and found that if their eyes were blinded they did not change, thus proving that the color cells were under the control of the nervous system. Day records that young hybrid salmon raised at Howietoun, in which vision was more or less deficient, were observed to be generally lighter in color than their fellows.

The fishes of the sea are more often brilliant than those of the river or the lake. Warmth and light are favorable to brightness and variety of hue. The fishes of circumpolar regions, and those living at considerable depths are, therefore, usually somber, though occasionally they have iridescent scales or plates of great brilliancy.

In temperate regions, as along the coasts of the United States, somber tones are most common, but in summer many sunny-hued strangers come up from the south.

In the tropical seas, however, the greatest beauty is to be found; and in some groups, such as the parrot fishes and the wrasses, the most bizarre and astounding combinations of masses of brilliant color. Harsh and inharmonious as they seem, however, when imitated by the brush, they are never unpleasing in the living creatures. The West Indian fauna has many wonderful fishes,—such as the angel fish, *Holacanthus ciliaris*; and the Spanish lady, *Bodianus rufus*—but the utmost possibilities of beauty are to be found only in the Southern Pacific and the Indian Oceans.

As Count Lacépède has so eloquently shown in the passage already quoted, no class of animals has been so richly endowed with color as the fishes, except it may be the insects; and the effect of brilliancy in a fish is much greater on account of its larger size. Birds appear at a disadvantage in comparison, because, except in the metallic patches on the throats of the humming bird and a few similar instances, the surfaces of their feathers are not so well adapted to display as the broad burnished sides of fishes, kept constantly moist and lustrous by contact with water.

The beauty of fishes can only be known to those who have had the good fortune to see them swimming at ease, bathed in the limpidest of water and the brightest of sunshine. Aquaria are always dark and gloomy, and their glass walls seem more prison-like than the bars of a menagerie cage. Museum preparations do not tell of the vanished beauty even so well as the lifeless bodies of the fishes themselves, and every angler knows how suddenly the dead fish loses its attractions of texture and color. This change has been well described by Dr. Badham in the following lines:

"While blazing breast of humming bird and Io's stiffened wing
Are bright as when they first came forth new painted in the spring,
While speckled snake and spotted pard their markings still display,
Though he who once embalmed them both himself be turned to clay,
On fish a different fate attends; nor reach they long the shore
Ere fade their hues like rainbow tints, and soon their beauty's o'er.
The eye that late in ocean's flood was large and round and full
Becomes on land a sunken orb, glaucomatous and dull;
The gills, like mushrooms, soon begin to turn from pink to black:
The blood congeals in stasis thick, the scales upturn and crack;
And those fair forms a Veronese, in art's meridian power,
With every varied tint at hand, and in his happiest hour,
Could ne'er in equal beauty deck, and bid the canvas live,
Are now so colorless and cold, a Rembrandt's touch might give."

—*Science.*

ASSUMPTION AND FACT IN THE THEORIES OF SOLAR AND STELLAR PROPER MOTIONS.

THE late R. A. Proctor, in one of his interesting astronomical works, calls attention to the imperfect knowledge displayed by many educated persons, and even by those of literary attainments, with regard to the true motions of the heavens; and he quotes several instances of amusing mistakes in publications of a high standard.

The present writer had strong confirmation of this general deficiency on a recent occasion when reviewing a reprint of astronomical lectures delivered years ago, the theories and deductions of which were not in accordance with the progress of astronomy in late years. Justice to the reading public having called for adverse comment, the publisher's statement that no other reviewer had to his knowledge criticised the book unfavorably attests the scarcity of correct astronomical information, which was still further demonstrated by a startling suspicion, expressed in a letter from an astronomer not unknown in Virginia, that the unpretending little review must have been penned by a prominent Californian astronomer.

Conspicuous in the pages of this reprint was the now refuted theory of a central sun swaying the universe, including the solar system. This mighty orb was, in a figurative sense, created and enkindled by M. Maedler of the Dorpat observatory, Russia, and enthroned with popular approval in the Pleiades under the aspect of Alcyone, a star of the third magnitude. Much as the human mind loves mystery, it also loves a solution, genuine, if such is attainable, but if not, a seeming insight is more acceptable than a hopeless negative. M. Maedler's theory, deduced from painstaking but erroneous calculations, though it never received unqualified endorsement in the foremost ranks of science, captured the credence of many astronomers, and to this day a number of persons who have studied their treatises are, in imagination, ranging the universe under the triple attraction of earth and sun and the unassuming Pleiad. To make it apparent how these theories are evoked or refuted, it may not be superfluous to explain some celestial terms, probably familiar, but perhaps not clearly understood. The term fixed, which is applied to all stars with the exception of a few classed as planets, has but a comparative signification since Halley in the early part of the eighteenth century called attention to the fact that many stars no longer hold the exact positions assigned them by Hipparchus and Ptolemy. As all know, the term never denoted that they were always to be seen in the same direction, for they share the effects of the earth's diurnal and annual motions; neither does it denote steadiness of light, for they are far more affected by scintillation than the planets; but until the period named, it signified that their positions with regard to one another were unchangeable.

The simple astronomical instruments devised by the ancients for the measurement of the heavens enabled them to map out with considerable accuracy the positions of the principal stars with regard to the ecliptic, the distance north or south of this celestial circle being rather inappropriately termed latitude. Owing to planetary attraction, this circle is subject to a variation back and forth within limits, and stellar latitudes are decreased and increased accordingly. The bright stars Aldebaran and Sirius, in the present season visible after dusk, were among those chosen by Halley to determine the extent of this variation. Expecting to find the latitudes decreased, he was much surprised to find them about half a degree south of the places assigned them on the maps of the ancients. Hitherto the fixedness of the solar system and the stellar hosts was regarded as a settled matter, and it seemed like shaking the universe to its foundation to suggest instability; consequently the astronomical world were slow in admitting that the changeless heavens were in truth quivering

with unseen motion in every direction; but before sixty years had passed, Halley's announcement of the proper motion was entirely corroborated by the observations of many eminent astronomers.

In a learned address entitled "Assumption and Fact in the Theories of Solar and Stellar Proper Motions," delivered some weeks ago by Prof. Eastman, the retiring president of the Microscopical Society of Washington, the evolution of this branch of astronomical knowledge is explained, and his enlightened deductions cannot fail to dispel the illusions that hover in the semi-scientific mind on this majestic theme. With the discovery of the proper motion of the stars came the supposition that it might be only apparent, and due to a real motion of the sun and its attendant planets onward through the vast wastes of space. Then naturally arose the questions, If such be the case, whither is the center of our solar system drifting? with what velocity? and under what laws?

To show that such queries are not prompted by wild yearnings to know the unknowable, it must be remembered that if we are in motion, objects around suffer displacement with regard to more distant objects in proportion to our motion, that those from which we recede or toward which we advance seem stationary, that near these points little change is shown, while midway or at right angles to our motion the greatest displacement appears. Also that if we know the distance of objects in the last named position, provided they have no perceptible motion of their own, we can then ascertain the extent and velocity of our own motion in a given time. It is not surprising to find many astronomers since Halley's eventful discovery devoting themselves earnestly to the solution of these queries, and Prof. Eastman gives an interesting account of the point of view from which the most eminent among them engaged in these investigations, as likewise the data on which their computations were based, and a conveniently tabulated record of results. Conspicuous in this laborious work were Cassini, Herschel, A. Struve, and Argelander, and the results arrived at by the last named astonomer settled in the affimative the question of solar motion.

Highly creditable to the human intellect is the deciphering of the accumulated testimonies written in faint stellar script, often neutral, often contradictory, though yielding, on the whole, a preponderating concurrent evidense.

As many stars, and sometimes whole groups of stars, showed a motion otherwise than in accordance with the general drift, it was reasonably assumed that the displacement by solar translation had been counteracted by independent motion in some other direction. Thus, though the proper motion of the sun and stars is accepted as an astronomical fact, there is still a wide field for theory and investigation. The isolated cases of false assumption associated with this achievement of human observation is no detraction from its greatness, and when we were informed as to what ruling power curved the majestic flight of our luminary, or at what astounding pace it winged the ether wastes, it was necessary to draw a line between proof and supposition, unless we chose to wing our own way into the unprofitable wastes of fancy. Prof. Eastman's paper is admirably fitted to curb these unscientific flights, and to encourage the patient, hopeful investigation which alone can unfold the mysteries of infinity.

That about half a second of arc is at present the best attainable estimate of the angular value of the sun's motion is probable, that the direction of translation lies in Hercules is well attested, and that in the course of ages that straggling constellation may widen as far apart as the east is from the west, while the sun and attendant planets pass into its midst, is among the possibilities; but the value in miles of that laboriously found half second of arc, or whether it is straight or curved, are mysteries to which all the past observations of man furnish little clew.

The few noted astronomers who sought a solution placed small reliance on their own deductions. The reason of this is evident when we consider that an extensive and accurate knowledge of stellar distances is the first requisite of success, as only from the combined testimony of an immense number of stars the distinct value of their own motion can be reliably deduced. Of the millions of stars strewn through the heavens, the parallax of only forty-six has been satisfactorily determined.

All computations up to the present time have been based on the assumption that, as a general rule, stars of the first magnitude are the nearest, having consequently the greatest parallax and the greatest proper motion. By careful personal investigation Professor Eastman proves that recent estimates are a direct contradiction of this theory.

Sirius, the largest star in the entire heavens, has a far smaller parallax than many faint stars scarcely discernible to the naked eye, and has less than one-fifth the proper motion of Groombridge, 1830, the famous flying star that changes position at the rate of seven seconds per annum. But disproof does not rest merely on isolated cases; he finds that as a general rule the larger proper motions and parallaxes belong to the smaller stars; that decrease in the numerical value of the parallaxes is accompanied by a corresponding decrease in the proper motions; and that stars of the ninth magnitude have a proper motion three times as great as the 2d, 3d, 4th, and 5th magnitudes.

Having proved effectively the unexpected degree to which assumption and fact are at variance, the retiring president adds: "If at this moment we knew the distance from the solar system of every star visible to the naked eye with an accuracy equal to the best work ever done in that direction, we should still be unable to solve the problem of the direction and the velocity of the motion of the solar system with a degree of precision commensurate with the importance of the question."

He then explains that the declinations in the maps of the ancients being untrustworthy, the stellar motions in the short period since reliable records exist are too insignificant to be discernible, and that at least a century must elapse before a satisfactory solution can be obtained. Nevertheless, disclaiming any pessimistic views as to future research, he encourages the observer not to grow fainthearted, but "to strive cheerfully to fix, for his epoch, the evidence of each member of that starry host of witnesses whose cumulative testimony will make clear sooner of later the laws that guide their motions through the depths of space."

EFFECTS OF RETARDED DISSOLUTION.

By H. N. WARREN, Research Analyst.

THE speedy dissolution of a zinc rod, when suspended in contact with such a menstruum as solution of lead acetate, cupric sulphate, or any readily precipitable metal, is always attended more or less by the copious development of a dense spongy metallic mass, which almost instantaneously incrusts the precipitant employed. In the case of a lead salt thus acted upon, which is frequently practiced by amateurs with a view of obtaining what is known as the lead tree, the incrustation that is formed, remaining in close proximity to the zinc, is never very striking as regards metallic luster, and it not unfrequently happens that a considerable course of time has elasped before the purer quality, which is characterized by its feathery appearance, begins to develop. If round the zinc rod, however, is wrapped a few coils of asbestos paper before applying the same, on now introducing the zinc into the solution a most interesting modified action accompanies it, the lead being slowly precipitated upon the outer surface of the asbestos. Notwithstanding it being a non-metallic surface, it continues to increase in size, gradually assuming large and perfect octahedrons of metallic lead, the asbestos covering thus acting in much the same manner as the first precipitated or porous quality. If a solution of cupric sulphate be substituted for that of the lead, and the same raised and maintained for some time at the boiling point, the whole of the copper is precipitated in regular crystals; in short, all the more easily reducible metals may, by the retarding action of the asbestos covering, be obtained in a crystalline form.

Among one of the most curious exceptions may be mentioned that of antimony. If to a solution of antimony chloride containing a sufficiency of a tartrate to prevent reprecipitation of basic salts is introduced the so prepared zinc, part of the antimony is set free, attaching itself in the usual form of crystals to the asbestos covering, while a second portion falls in the state of an amorphous black powder, resembling in appearance ordinary lamp-black. This, when raised to an elevated temperature, is oxidized with explosion, being what is known as explosive antimony.

For a further and more complete study of retarded action may be mentioned the withdrawal of the zinc and the replacement of magnesium for the same. By this means zinc was crystallized in a perfectly metallic state, and communicating to the same an arborescent form. Iron, manganese, and even zirconium, were gradually reduced.—*Chem. News.*

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